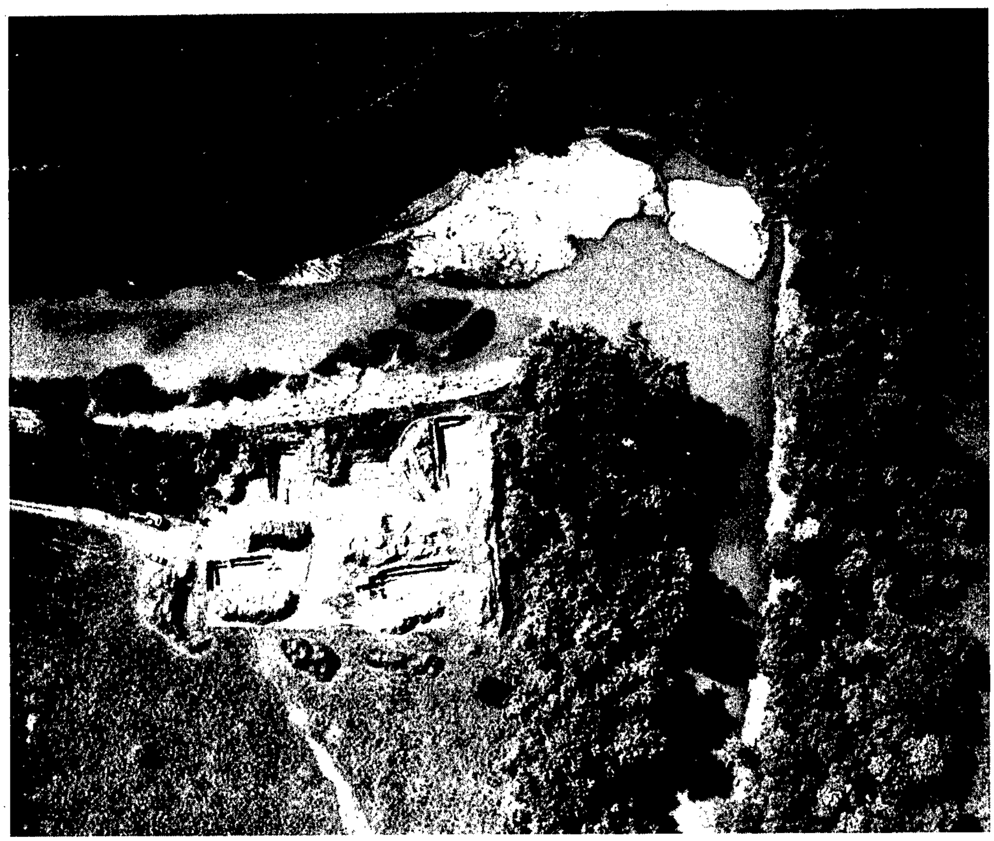
THE 1997 EXCAVATIONS AT THE BIG EDDY SITE (23CE426) IN SOUTHWEST MISSOURI

Edited by
Neal H. Lopinot, Jack H. Ray,
and Michael D. Conner



Center for Archaeological Research

SPECIAL PUBLICATION NO. 2

SOUTHWEST MISSOURI STATE UNIVERSITY

US Army Corps
of Engineers
Kansas City District

Contract No. DACW41–95–D–0016
Jack H. Ray and Neal H. Lopinot
Principal Investigators
1998

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With Contributions by
Edwin R. Hajic
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Rolfe D. Mandel
Jack H. Ray
Bonnie W. Styles

Report Submitted to
United States Army Corps of Engineers
Kansas City District

Report Submitted by
Burns and McDonnell, Inc.
Kansas City, Missouri

Investigations Conducted by
Center for Archaeological Research
Southwest Missouri State University
Springfield, Missouri
Jack H. Ray and Neal H. Lopinot, Principal Investigators
CAR Project 1037

Special Publication No. 2
Center for Archaeological Research
Southwest Missouri State University
Springfield, Missouri
1998

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
November 24, 1998

3. REPORT TYPE AND DATES COVERED
Final: 1997-1998

4. TITLE AND SUBTITLE
The 1997 Excavations at the Big Eddy Site (23CE426) in Southwest Missouri

5. FUNDING NUMBERS
DACW41-95-D-0016

6. AUTHOR(S)
Edited by Neal Lopinot, Jack Ray, and Michael Conner; contributions by Lopinot, Ray, Edwin Hajic, Rolfe Mandel, and Bonnie Styles

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Center for Archaeological Research, Southwest Missouri State University, 901 S. National, Springfield MO 65804-0089; and Burns & McDonnell, Inc., 9400 Ward Parkway, Kansas City, MO 64114

8. PERFORMING ORGANIZATION REPORT NUMBER
Center for Archaeological Research, Special Publication No. 2

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers, Kansas City District, 700 Federal Building, 601 East 12th Street, Kansas City, MO 64106-2896

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release; unlimited distribution

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Extensive archaeological and geoarchaeological investigations at the Big Eddy site (23CE426) in the Downstream Stockton easement have documented stratified archaeological deposits extending to at least 4.0 m below surface in the central part of the site. This locality was utilized throughout prehistory, but perhaps most intensively during Late Paleoindian and middle Late Archaic times. The site also contains significant Early Archaic, Early/Middle Paleoindian, and possible pre-Clovis components, and has yielded the first reliable dates associated with a fluted point component in this portion of the midcontinent. Reliable dates also have been obtained for the Late Paleoindian horizon, which lies directly above the fluted-point horizon and contains abundant lithic debris produced by Dalton and San Patrice peoples. Based on sedimentological data, thin-section analysis, refitting studies, microdebitage distribution, and the intact nature of numerous lithic features, the early deposits at the Big Eddy site have very good integrity. Analyses focus on site formation processes and dating, carbon isotopes, an extensive lithic (principally chipped-stone) assemblage, a modest archaeobotanical data set, and limited faunal remains. Given the site's great significance and continued erosion, mitigation should be undertaken as soon as possible.

14. SUBJECT TERMS
Pre-Clovis, Paleoindian, Archaic, Woodland, Mississippian, Sac River, geoarchaeology, Rodgers Shelter member, carbon isotope, chert exploitation, archaeobotany

15. NUMBER OF PAGES
440

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

ABSTRACT

Extensive archaeological and geoarchaeological investigations were conducted in 1997 at the Big Eddy site (23CE426) in central Cedar County, southwest Missouri. This work was undertaken for the Kansas City District, U.S. Army Corps of Engineers, by the Center for Archaeological Research, Southwest Missouri State University under the auspices of Burns and McDonnell, Inc. and in accord with Contract No. DACW41-95-D-0016. The investigations at Big Eddy resulted in the delineation of Mississippian, Woodland, Archaic, Paleoindian, and possible pre-Clovis components in stratified alluvial contexts.

The excavations focused on mitigation of late-prehistoric deposits near the surface of the site, and on the examination of earlier prehistoric cultural deposits in deeply buried and previously undefined late Pleistocene to late Holocene alluvium. Two major geomorphic alluvial members were defined at the site—the Rodgers Shelter and Pippins Cemetery members. At the Big Eddy site, the Rodgers Shelter member is composed of at least three distinct alluvial fills, tentatively identified as early, middle, and late submembers. Relatively thick units of early to middle Holocene and late Holocene alluvium, corresponding generally to the middle and late submembers, occur in the western part of the site. Near the center of the site, all three submembers occur in a single stacked profile that dates from late Pleistocene through late Holocene times. The character of buried deposits in the eastern part of the site remain unknown, although coring indicates that all three submembers are also represented in this area.

Late Archaic, Woodland, and Mississippian artifacts and deposits were found in the late submember, and at least some early Late Archaic artifacts also were found in the upper part of the middle submember. Within the late submember, late-prehistoric features and a rich middle Late Archaic midden were identified, and numerous diagnostic artifacts were collected. The excavations showed that the late submember is extremely thick and well stratified in the western part of the Big Eddy site, with artifact-bearing deposits extending from the surface to a depth of at least 2.6 m and possibly much deeper.

One corner of an approximately 30-cm-thick midden dating to middle Late Archaic times was found buried within the thick late submember in the western part of the site. This deposit is potentially quite extensive and contains abundant plant and animal remains (though mostly calcined), as well as numerous diagnostic chipped-stone tools, debitage, and other lithic debris (e.g., hematite and ground-stone tools). Preliminary evidence for relatively early cultivation of at least chenopod has been obtained, although more detailed study is needed. Cultural features, perhaps including structural remains, should occur in the vicinity of this midden.

The middle submember was the least investigated alluvial unit at the site. Nevertheless, it has considerable potential for delineating discrete components dating to the Middle and Early Archaic periods. Middle Archaic activities at the site appear to have been limited, at least within those parts of the site tested. Early Archaic activities, however, appear to have been fairly extensive, and the deposits dating to this period are relatively thick, offering the potential for identifying early and late Early Archaic components, related cultural activities, and changing paleoecological conditions.

The early submember of the Rodgers Shelter member is about 2.2 m thick in the the central part of the site, and it was the primary focus of attention in 1997. It contains stratified multiple Paleoindian components underlain by pre-Clovis-age deposits. These findings alone are unprecedented for a site in midcontinental North America. A relatively large suite of radiocarbon ages from the early submember indicates that this alluvium aggraded during the Pleistocene-Holocene transition, or about 13,000 to 10,000 B.P.

A relatively discrete, anthropogenically enriched 3Ab horizon lies at a depth of about 2.9–3.2 m below surface (bs). Radiocarbon dates from this horizon indicate deposition between about 10,500 and 10,000 B.P. In situ Dalton, San Patrice, and Wilson points were recovered from within the 3Ab horizon. Block excavations revealed an abundance of debitage resulting from relatively intensive use of this part of the site as a tool-manufacturing workshop associated with at least the Dalton and San

Patrice components. Sixteen discrete debitage features and several manuported gravel piles were defined within these deposits. The recovery of scrapers, drills, adzes, and other Late Paleoindian tools indicate that domestic activities were conducted at the site in addition to intensive tool manufacturing.

Earlier Paleoindian tools and debitage were recovered from below the base of the 3Ab horizon in an underlying 3Bt1 horizon. The oldest diagnostic artifact consisted of two refitted fluted-point fragments, tentatively identified as parts of a Gainey point, that were found at about 3.3 m bs. The nearest associated AMS age is around 10,700 ± 200 B.P., although six of the eight AMS ages from this horizon form a time range of 10,700–11,400 B.P. These radiocarbon ages indicate the presence of cultural materials dating to both Middle Paleoindian and Early Paleoindian times, as these time spans are currently defined. The depositional integrity of artifacts within these deposits also is good, given the data obtained from geoarchaeological research.

Artifacts were found to about 3.9 m bs. However, deposits below about 3.5 m bs were the subject of very limited investigation, so our knowledge of artifacts and site-formation processes below this depth remain limited. As such, the presence of pre-Clovis-age cultural deposits at the Big Eddy site is inconclusive. In any regard, pre-Clovis-age deposits (based on currently accepted dates associated with Clovis fluted points) are present and what appear to have been in situ artifacts (debitage and manuports) were recovered from deposits that date to approximately 11,900 B.P. Below is a gravel bed and another meter or so of essentially unexamined deposits dating to about 13,000 B.P. and earlier. Charcoal fragments occur in the uppermost part of these deep deposits, but it is uncertain if these materials are cultural or natural (i.e., due to natural fires).

The Big Eddy investigations have resulted in several radiocarbon "firsts" and provide a generally reliable sequence based on a relatively large number of AMS, standard, and soil-humate age determinations. Because of the site's good depositional integrity, the Big Eddy site has great potential for characterizing artifact assemblages and for understanding various aspects of changing settlement-subsistence strategies, lithic-procurement practices, and paleoecological conditions for Early, Middle, and Late Paleoindian times. The potential information that could be obtained for both later and possibly earlier times is also great.

Relatively reliable dates from the Big Eddy site are associated with Williams, Smith, Etley, San Patrice, Dalton, and Gainey bifaces. Numerous other diagnostic point types represented in private collections from the site have yet to be found in stratigraphic context. The pulses of sediment aggradation make Big Eddy ideal for defining the relative stratigraphic position of such diagnostic bifaces, and the presence of scattered bits of charcoal throughout these deposits demonstrates the potential for obtaining a reliable biface chronology for this portion of the midcontinent.

Extensive archaeological, geoarchaeological, and paleoecological investigations should be undertaken at the Big Eddy site in the very near future. Such investigations need to be implemented in the next two to three years, or else major portions of the remaining deposits may be lost forever. Basic elements of a program of mitigation are presented in this report. This program focuses on the mitigation of the Early Archaic through pre-Clovis-age deposits but not to the exclusion of later deposits. An interdisciplinary approach is emphasized.

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ACKNOWLEDGMENTS

Many individuals from a variety of backgrounds contributed time, labor, coordination, and valuable information to the completion of the Big Eddy project. The project was sponsored by the Kansas City District of the U.S. Army Corps of Engineers. We thank Bob Ziegler, archaeologist at the Kansas City District office, and Ken Lucius, cultural resource specialist at Stockton Lake, for their assistance. Project funds were managed by Burns and McDonnell Inc. with Project Manager Dan Shinn providing overall coordination of the work.

We thank landowners Nina Howard and Dallas Kramer for granting access to their property and allowing field work to proceed in a timely fashion. We extend a special thanks to Mrs. Howard, who also graciously donated the artifact collection from the Big Eddy site to Southwest Missouri State University for permanent curation.

A number of very able workers assisted in the field work. The core crew who bore the brunt of the work are Kary Stackelbeck, Greg Maggard, Carl Shields, Terry Anderson, Walt Morton, Marc Wampler, George Crawford, and Jack Ray (see Frontispiece). Others who assisted with some field work included Neal Lopinot, Mike Conner, Larissa Thomas, John McRaven, John Bogatko, Matt Coffer, Richele Lake, Matt White, Don Brink, and Dan Shinn. Subcontractor Carter Excavating Company conducted heavy-machinery work. Bon (Skip) Andrus operated the trackhoe and road grader with amazing precision. As usual, lab and office work was conducted in a very thorough and timely manner by Patsy Corbett and Pam Burrier, respectively. Del Thompson volunteered to make line drawings of all diagnostic Paleoindian artifacts found during the excavations. We are especially indebted to Mike Conner for producing numerous high-quality report figures and tables and for editing the report.

Several individuals from the Stockton area provided valuable information and assistance. First, we thank Dan Long, Charles Collins, Terry Collins, Terry McCurdy, A. Clark Montgomery, and Aaron Brauer, who allowed us to inspect and photograph their artifact collections from the Big Eddy site. Aerial photographs of the site were made possible with the assistance of Pete Nichols, Bob Estes, Leland McMasters, and Stewart Thompson. Finally, Clark I. Montgomery and Pat Steffenson graciously provided equipment to help build a fence around the site as well as canoes for weekend reconnaissance/pleasure trips down the Sac River.

Specialized analyses were provided by several consultants: Rolfe Mandel and Ed Hajic (geomorphology), Eric Grim (palynology), Bonnie Styles (zooarchaeology), Carolyn Colonero (stable carbon isotope), and Glen Fredlund, Mary Jo Schabel, Charles Rovey, Tom Hallmark, and Donna Prochaska (sedimentology, soil chemistry, and clay mineralogy). Tom DeWitt (Missouri soil scientist) provided supplementary data on local soils. Radiometric analyses were conducted by the University of Arizona, the University of Texas, and Beta Analytic, Inc. Kary Stackelbeck spent considerable time in the lab with the Paleoindian material and established a number of refit specimens. We would also like to thank Bruce McMillan and Terrence Martin of the Illinois State Museum for access to the Rodgers Shelter collection and James Krakker of the Smithsonian Institution for access to the Afton Sulphur Spring collection.

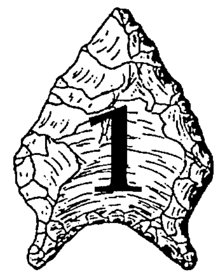
Finally, we wish to thank the following individuals who visited the site and/or shared their vast experiences with Paleoindian artifacts and sites, including deeply buried sites such as nearby Rodgers Shelter: C. Vance Haynes, R. Bruce McMillan, W. Raymond Wood, Marvin Kay, Dennis Stanford, Peggy Jodry, Julie and Toby Morrow, Tom Dillehay, Mike O'Brien, and Lee Lyman.

Jack H. Ray
Neal H. Lopinot
Principal Investigators

1997 BIG EDDY EXCAVATION CREW

Top row (left to right): Neal Lopinot, Jack Ray, George Crawford. Middle row (left to right) Kary Stackelbeck, Greg Maggard, Terry Anderson. Bottom row (left to right): Marc Wampler, Carl Shields, Walt Morton.

INTRODUCTION



Neal H. Lopinot

This report describes excavations conducted in 1997 at the Big Eddy site (23CE426) in southwest Missouri. The site is located below Stockton Lake along the lower Sac River in Cedar County. Big Eddy contains remarkable stratified archaeological deposits spanning the entire known prehistoric sequence, beginning about 12,000–11,500 radiocarbon years ago and ending about 500 years ago. Of particular importance are the extensive Paleoindian occupations; residues of these occupations occur in stratified, well-dated deposits. In addition, relatively thick pre-Clovis-age or terminal Pleistocene deposits extending back to at least 13,000 years ago also occur at Big Eddy, but these were subject to only limited investigation and clear evidence for use of the site prior to Paleoindian times is currently lacking.

The United States Army Corps of Engineers (USACOE), Kansas City District maintains Stockton Lake, a facility that was authorized for flood control, hydropower, water quality, navigation, recreation, and fish and wildlife. Part of the Corps' responsibility entails the care and treatment of archaeological sites downstream from Stockton Dam within sloughing and flowage easements bordering the Sac River. Although the Corps has jurisdiction over the care of the sloughing easements, the sites are privately owned. Several sites partially or entirely within these easements have been determined eligible for the National Register of Historic Places (NRHP). Unfortunately, power-generation water releases from the dam continue to cause substantial cutbank erosion and site attrition (Ziegler 1994). The USACOE Kansas City District and the Missouri State Historic Preservation Office completed a Memorandum of Agreement (MOA) in 1991 that formally identified sites eligible for the NRHP that were being adversely effected by releases from Stockton Dam. As a result of this MOA, the USACOE identified four sites (23CE238, 23CE255, 23CE401, and 23CE426) requiring priority treatment for data recovery.

The four priority sites were known to be extensive and multicomponent based on surface survey, test excavations, and cutbank observations (Moffat and Houston 1986; Roper et al. 1977; Schmits 1988; Ziegler 1994). Due to the nature of ongoing erosion, the meandering character of the Sac River, and the continuation of current water-management practices, it was not considered realistic or economically feasible to preserve the remaining parts of the sites within the sloughing easements. Phase III data recovery was chosen as the most viable option for mitigating future impacts to remaining portions of the four sites. As a result, data recovery plans (DRPs) were developed by Lopinot and Yelton (1996).

Preparation of the DRPs involved field visits to the four sites. During these visits, three sites were discovered to contain deeply buried cultural deposits that had not been documented previously. One of these, 23CE426, subsequently named the Big Eddy site, proved to contain the deepest and richest deposits. Owing to the new findings and the projected increased costs of mitigation, it became economically feasible to select only one site among the four for immediate attention. The Big Eddy site was chosen by the USACOE, and a proposal was solicited by Burns and McDonnell, Inc. from the Center for Archaeological Research (CAR) to conduct the mitigative investigations as a subconsultant under open-ended contract DACW41–95–D–0016.

This report describes the results of excavations at the Big Eddy site (23CE426), located on the right

bank of the Sac River a little more than 9.6 km downstream from Stockton Dam in the so-called Downstream Stockton Unit. The Downstream Unit of Stockton Lake is in central Cedar County, Missouri, and encompasses the upper segment of the lower Sac River, that portion extending from Stockton Dam to Caplinger Mills. The Big Eddy site lies in the Sac watershed of the Osage Prairie principal drainage basin of the Missouri River major drainage basin as defined by Weston and Weichman (1987) (Figure 1.1). More specifically, the site is situated in irregular Section 4, T34N R26W of the fifth principal meridian (Figure 1.2). It occurs in the southwest corner of a large pasture, almost exclusively on property owned by Nina Howard. It was first reported to the Archaeological Survey of Missouri on May 20, 1986, by Environmental Systems Analysis, Inc., as a result of a survey of 140 acres of sloughing easement below Stockton Dam. Prior to the 1997 investigations by CAR, the Big Eddy site was the scene of survey and testing work reported by Schmits (1988) and Ziegler (1994). The site is also well known to collectors, including some from at least as far away as Joplin, Missouri (based on encounters in the field and information supplied by collectors).

PREVIOUS INVESTIGATIONS BELOW STOCKTON DAM

Phase I Archaeological Surveys

The Kansas City District has sloughing easements of 609.7 ha (1,506 acres) and flowage easements of 18.6 ha (46 acres) below Stockton Dam and extending to the upper reaches of Truman Reservoir. These easements were purchased to allow the Kansas City District to flood and erode such lands by water releases from the hydroelectric dam. A considerable amount of archaeological research has been undertaken within these easements since 1976.

The first professional survey in the Downstream Stockton Unit was undertaken in 1976 by the University of Missouri (UM) (Roper et al. 1977). This survey resulted in the revisitation of four previously recorded sites and the recording of 40 new sites within a 9-km^2 area between Stockton Dam and Caplinger Mills. Nineteen of the new sites and two of the revisited sites occur within the present sloughing easement. For the sloughing easement itself, the UM survey involved an area of 319.4 ha (789 acres) from Stockton Dam to Caplinger Mills and included that portion of Bear Creek below Owen's Mill, where the creek emerges onto the Sac River floodplain at the Highway M bridge. The survey involved pedestrian and shovel-probing methods, supplemented by a canoe survey of those areas that were "difficult to reach by pedestrian survey" (Roper et al. 1977:29). The UM report also contains historical information on Cedar Mill, Caplinger Mill, and Owen's Mill (Roper et al. 1977:144–147).

After a hiatus of about eight years, investigations downstream were renewed. Another 161.9 ha (400 acres) within the sloughing easement were surveyed in 1984 and 1985 by American Resources Group (ARG). Twelve prehistoric sites were found within the easement and 12 sites (11 prehistoric and one historic) were found adjacent to the easement (Moffat and Houston 1986). Survey methods included pedestrian surface examinations and shovel probing. Cutbanks also were examined for eroding materials where possible during the survey and by canoe. As part of this project, ARG also undertook Phase II testing of the 12 newly discovered sites within the easement as well as three previously recorded sites (see below).

The next major project involved survey and testing in 1986 by Environmental Systems Analysis (ESA) (Schmits 1988). Two separate surveys were undertaken by ESA. The first was undertaken in 1986 for 13 parcels of land comprising a total of 148 acres of sloughing easement. The results are incorporated in the testing report by Schmits (1988). The surveyed parcels included several previously unsurveyed portions of the Downstream Unit, as well as sections in Reaches A and B below Caplinger Mills. Four new sites and the old partially standing Highway J bridge (23CE424) were examined for this survey. Big Eddy was one of the new sites; it was subsequently tested by ESA later in 1986.

In 1988, Schmits also submitted a letter report to the Kansas City District reporting on nine additional sites (23CE437–444 and 23CE446) found eroding out of cutbanks along the Sac River. Completed ASM forms were submitted to the state site files and all but two of these sites were tested by Historic Preservation Associates (HPA) (Klinger et al. 1992).

Since 1986, A. Clark Montgomery, a local landowner, has recorded numerous sites in Cedar County. He recorded six new sites (23CE430–435) below Stockton Dam prior to 1989 and has diligently continued to monitor a number of sites on

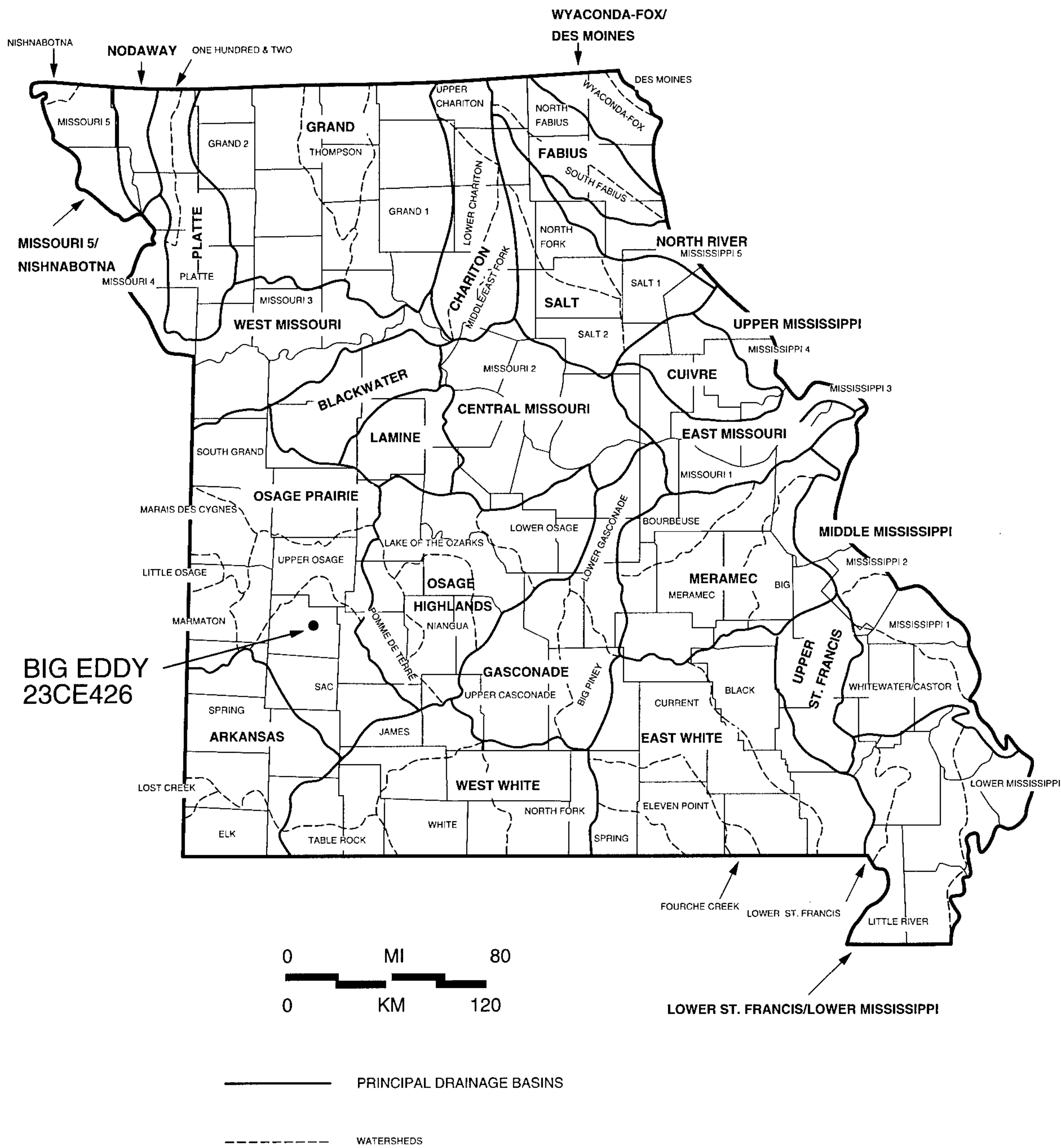


Figure 1.1. Location of the Big Eddy site in relation to Missouri watersheds and drainage basins.

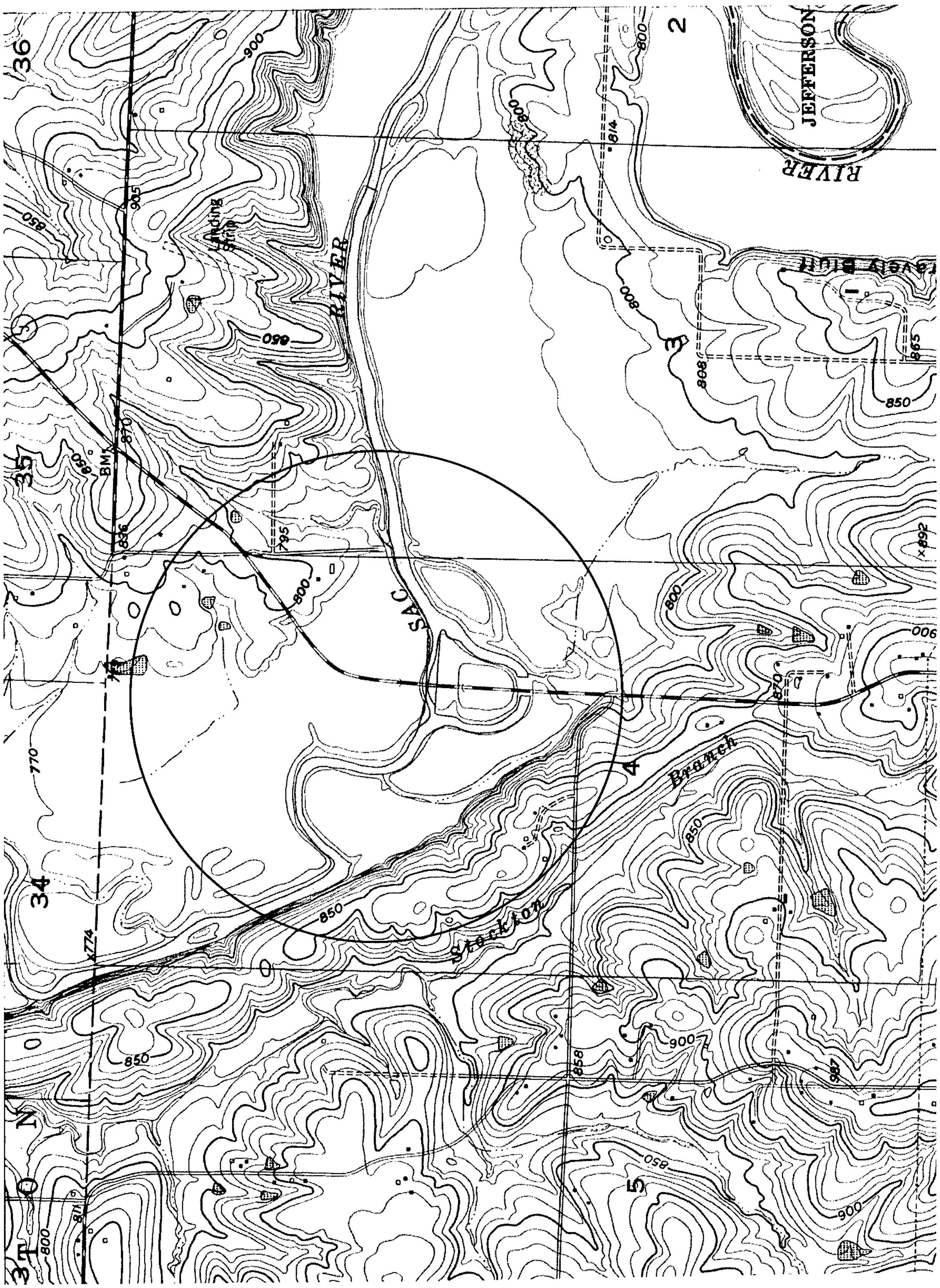


Figure 1.2. General location of Big Eddy site in the Sac River valley (Stockton 7.5' quadrangle,1956, photo revised 1981).

family property and in many other downstream locations on properties owned and/or managed by other families. More importantly perhaps has been his ongoing efforts, and those of his father and brother, to protect sites from collectors and looters.

Ziegler (1994) conducted monitoring of all previously recorded sites within the sloughing easements below Stockton Dam in 1989. During the course of his investigations, which involved visitation of sites along the Sac River and lower portions of tributaries by canoe, he identified four additional sites eroding from cutbanks in the Downstream Unit. These were recorded in 1992 as 23CE489–492.

During the 1997 investigations at the Big Eddy site, continued monitoring of sites and cutbanks was undertaken in the Downstream Unit by CAR staff. As part of this research, an effort was made to identify sources for some of the chert found at the Big Eddy site. In the process, three additional sites (23CE499, 23CE500, and 23CE501) were recorded by Jack Ray; 23CE499 and 23CE500 are within the sloughing easement. One (23CE499) appears to be a general habitation site, and the other two are chert-extraction and workshop sites located upstream from the Big Eddy site. Site 23CE501 is associated with the procurement and reduction of Chouteau chert, and 23CE500 is associated with an outcrop of high-quality Jefferson City chert.

Phase II Archaeological Testing

A long-term program of test excavations has been undertaken in the Sac River valley below Stockton Dam. A relatively large number of sites has been examined. This partially offsets the fact that few sites in the middle Sac River valley were salvaged prior to inundation by Stockton Lake. Thus, the importance of evaluating sites in bottomland contexts below the dam is accentuated, particularly since many sites are literally falling in the river.

The substantial efforts put forth by various researchers, supported by funding from the USACOE Kansas City District, have been laudable and the results are of considerable value. Nevertheless, it must be noted that the level of testing at many of the sites could be regarded as quite limited in light of recent findings in the lower Sac River valley and the more extensive Phase II testing undertaken recently for some federal and state agencies. It seems clear that the recommended NRHP eligibility for some, and perhaps all, sites should be re-evaluated, or at least reconsidered, owing to what might be perceived as inadequate testing, particularly of potential deep deposits.

The following site-by-site descriptions are presented to illustrate the great potential of many sites in the lower Sac River valley, including some that have been deemed not eligible for the NRHP. In addition, these descriptions will illuminate the limitations of previous investigations and illustrate the need for continuation of cutbank surveys and the implementation of more-intensive testing programs, as well as mitigative efforts. The locations of described sites are shown in Figures 1.3–1.5.

Montgomery Site Investigations

During the course of the original 1976 survey by the UM, cutbanks were investigated via canoe. This resulted in the identification of the Montgomery site (23CE261), where a Dalton point was found in association with flakes eroding out about 3.0 m below the surface along the outer bank of a large meander loop. A bank profile was subsequently cleared to verify if materials were indeed in situ, and contact was made with Charles D. Collins, who had been monitoring the site for the previous five years and had amassed an extensive collection (Donohue et al. 1977). With the realization of the potential importance of the Montgomery site and the severity of erosion, more-extensive excavations were undertaken in November of 1976 (Collins et al. 1983).

The excavations and cutbank monitoring at the Montgomery site indicate that it is actually "a series of discrete occupations at different, although possibly overlapping, points both vertically and horizontally along the entire meander cutbank" (Collins et al. 1983:12). Several trenches and units were placed along the cutbank where eroding materials were observed. This resulted in the recovery of relatively abundant numbers of artifacts at depths of 4.10–4.65 m below datum (bd) or about 2.70–3.25 m below surface (bs). The greatest densities were apparent at 4.35–4.55 m bd, or about 2.95–3.15 m bs (Collins et al. 1983:Tables 2–4). Although no projectile points were recovered in any of the excavations, Collins, a geologist by training, recorded the horizontal location and depths of any in situ projectile points and tools found during his years of cutbank monitoring (Table 1.1). He found nine Dalton points in the high-density zone between 2.9 and 4.0 m bs. Interestingly, this is also the depth range

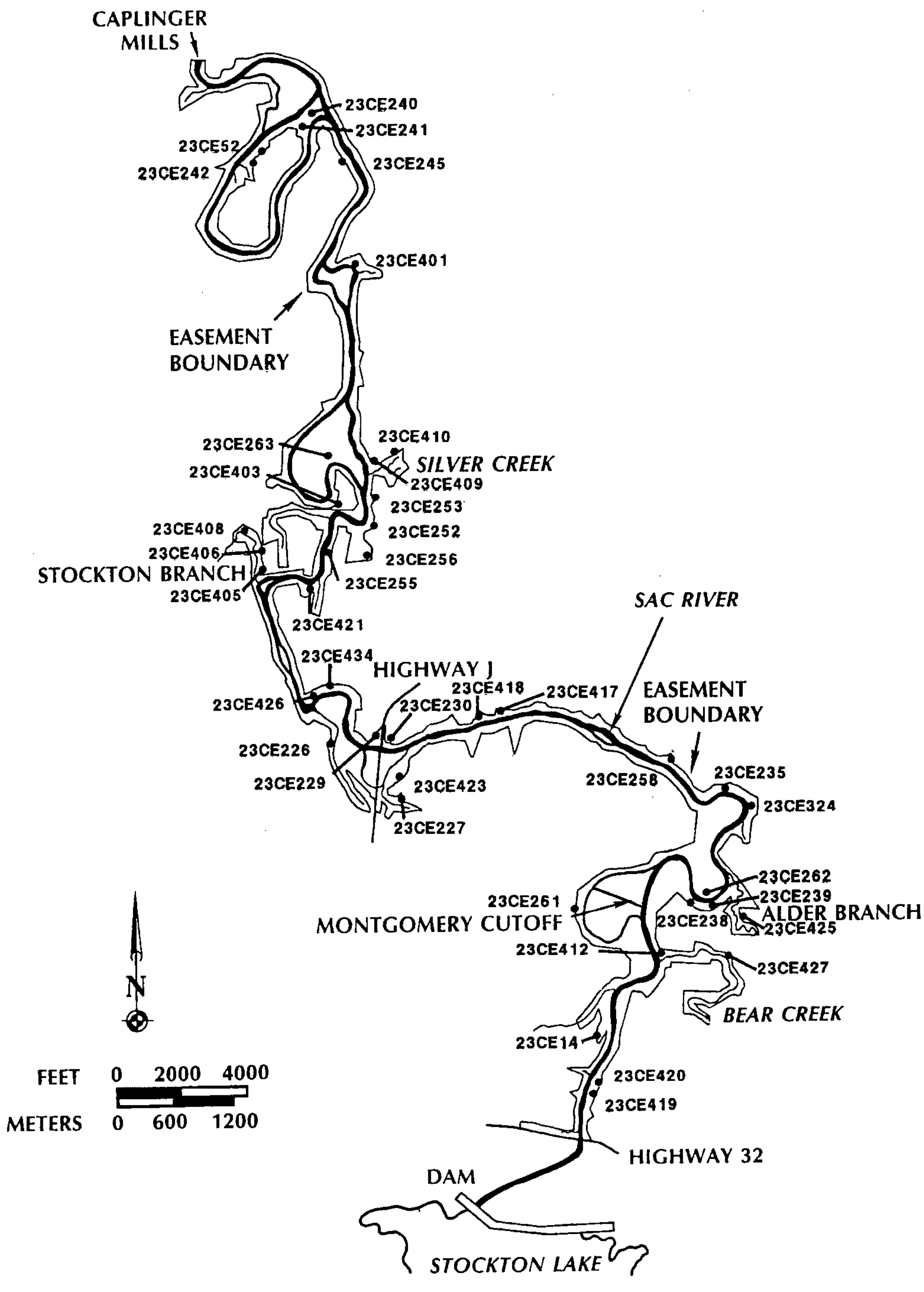


Figure 1.3. Tested sites in the downstream unit: Stockton Dam to Caplinger Mills (adapted from Ziegler 1994).

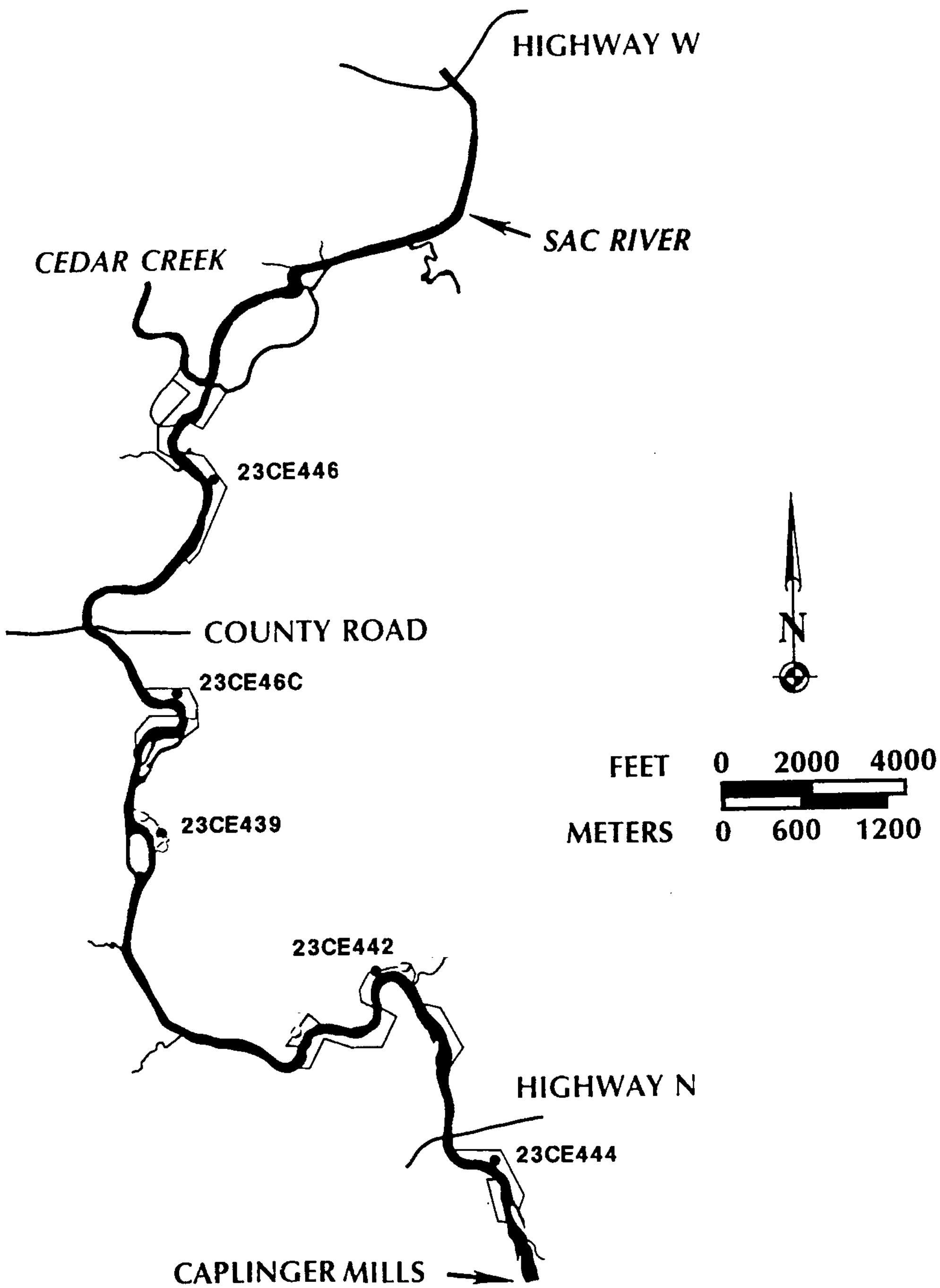


Figure 1.4. Tested sites in Reach A: Caplinger Mills to Highway W (adapted from Ziegler 1994).

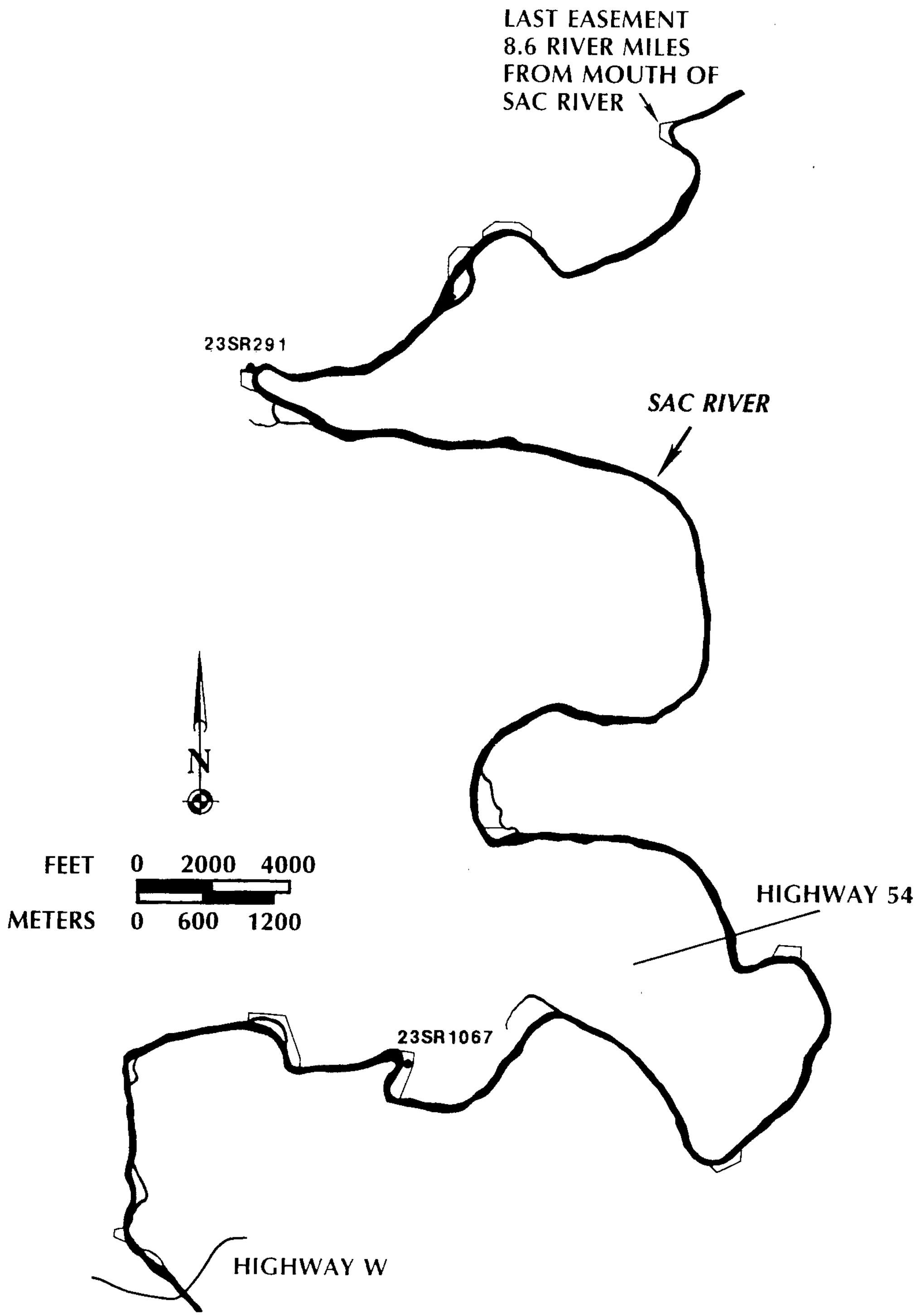


Figure 1.5. Tested sites in Reach B: Highway W to the last downstream easement (adapted from Ziegler 1994).

Table 1.1. Depths of Projectile Points at the Montgomery Site (adapted from Collins et al. 1983:69–72).

Type	Number of Specimens	Recorded Depths (m bs)
Rice Lobed	2	2.4, 2.7
Cache River	1	2.8
Dalton	9	2.9–4.0
"Agate Basin" (Packard)	1	3.2
Graham Cave	2	3.4 (average)
Breckenridge (?)	1	3.4
Scottsbluff	1	3.7
Plainview	1	3.8
Unnamed shouldered biface	1	5.6

with the greatest density of Late Paleoindian material at the Big Eddy site.

Collins also recovered a large number of points not found in situ (Collins et al. 1983). In the total collection, Dalton points (n=39) far outnumber all other point types, which indicates that the primary component identified at 2.95–3.15 m bs is Dalton. The fact that many of the other points are Late Paleoindian and Early Archaic types indicates that primary use of this site was about 10,500–9500 B.P. Although no charcoal was observed, or at least collected, (since this work was undertaken prior to accelerator mass spectrometry dating), the only radiocarbon date derives from a carbon sample from a log found near the base of the terrace fill at 4.77 m bs. This sample yielded a date of 9800 ± 120 B.P. (SMU-444; Johnson et al. 1993:648), a date that is probably considerably too recent in light of finds at the Big Eddy site and elsewhere.

Dalton use of the Montgomery site was interpreted as perhaps having been ephemeral and not unlike that represented at Rodgers Shelter (Collins et al. 1983:89). The absence of any midden stains and the appearance of debris concentrations, most measuring no greater than 10–15 m in extent, could be regarded as support for relatively temporary but frequent reoccupation of the site. The dominance of secondary flakes over tertiary flakes in the hand-excavated units also is suggestive of the production of bifacial preforms for retooling or curation. Although the collections from the site are undoubtedly biased in favor of projectile points/knives, relatively few other tools are represented, and none were found in the hand-excavated units. Tools collected from the cutbank and displaced deposits below the cutbank include drills, scrapers, adzes, nutting stones, and a hammerstone (Collins et al. 1983:73–74).

The limited investigations at the Montgomery site provided the first evidence for deep burial of deposits in the lower Sac River valley. Alluvial aggradation during the late Pleistocene through the middle Holocene also provides a good explanation for the apparent paucity of Paleoindian and Archaic sites in the valley. Sites earlier than Late Archaic are generally missed since survey work typically involves surface inspection alone, and opportunities to examine deep cutbank exposures like those below Stockton Dam are uncommon. In any regard, Clark I. Montgomery, the landowner, saw fit in 1977 to open an earlier channel at the neck of the loop, thereby cutting off the loop and protecting the site from further erosion. The site was placed on the NRHP on September 21, 1978.

Center for Archaeological Research Testing Project

A long-term testing program below Stockton Dam was initiated by the Corps of Engineers in 1981. In 1981 and 1982, CAR undertook test excavations at five prehistoric sites (23CE235, 23CE240, 23CE241, 23CE252, and 23CE324) between the dam and Caplinger Mills (Perttula and Purrington 1988; Purrington 1988; see Figure 1.3). Three sites (23CE235, 23CE252, and 23CE324) were tested in

1981; the other two were tested in 1982. Based on the recovery of contracting-stemmed Langtry points (Early/Middle Woodland) and/or corner-notched arrowpoints (Late Woodland), the three sites examined first were considered to have been limited-activity sites that were utilized principally or exclusively during Woodland times. One of these, the Ronnie Pyle site (23CE252), exhibited the greatest density of materials. Fire-cracked rock was common, which is perhaps indicative of the presence of features. Lithic debris from the Ronnie Pyle site also indicates that the bulk of activities involved biface manufacture and maintenance, flake-tool production, cutting and scraping of plant and animal tissues, and nut/seed processing. Chert was obtained principally from the local stream gravels, with some preference for Jefferson City chert. The two sites tested in 1982, 23CE240 and 23CE241, yielded little additional information beyond that obtained during the original survey by Roper et al. (1977). Both produced very low densities of materials, implying very short-term or intermittent use.

Cutbanks along the Sac River were exposed for examination at three sites during the period of Perttula and Purrington's (1988) investigations. Nothing was found by thorough examinations of the cutbanks and, at 23CE241, the excavation of a profile 1 m wide by 2 m deep into the cutbank. A small amount of debris, however, was found about 80 m downstream from what was designated as a new site, 23CE324. With one exception, the maximum depth attained by hand excavations at the five sites was 60 cm. The lone exception was Unit A at 23CE240, which was dug in 10-cm levels to 150 cm. Then a screw auger was used to further excavate in 10-cm increments down to 245 cm. Four flakes were found in sub-plow-zone contexts as a result of this work; they occurred in Levels 5 (40–50 cm bs), 7 (60–70 cm bs), and 9 (80–90 cm bs). Only one of the five sites, 23CE252, was assessed as being eligible for the NRHP.

American Resources Group Testing Results

Fifteen sites were tested by ARG in 1985: 23CE14, 23CE255, 23CE256, 23CE401, 23CE403, 23CE405, 23CE406, 23CE408, 23CE410, 23CE412, and 23CE417–421 (Figure 1.3). Three were previously recorded, and the other 12 sites were defined within the sloughing easement by the ARG survey. Nine of the 15 tested sites were determined to be eligible for the NRHP, although only two (23CE255 and 23CE401) were noted as being seriously affected by cutbank erosion in 1985. Except where noted otherwise, all of the hand excavations by ARG were undertaken in 10-cm levels.

Surface collections at site 23CE14 resulted in the definition of three artifact concentrations designated Loci A-C. Three 2-x-2-m units were dug in Locus B, the largest of the three loci. One was excavated to 80 cm bs, and the other two were excavated to 40–50 cm bs. Although no ceramics were recovered, an abundance of lithic material was obtained, including 20 projectile points. These consisted of singular examples of four different Late Archaic point types: five Gary Contracting Stemmed points, seven Langtry Contracting Stemmed points, two Early/Middle Woodland contracting-stemmed preforms, one Scallorn arrowpoint, and one Madison Triangular arrowpoint. In situ artifacts were recovered from sub-plow-zone contexts at 23CE14. Deeper excavations were not undertaken, nor was a nearby cutbank profile available for examination. This site was recommended as eligible for the NRHP.

Site 23CE255 had been recorded by Roper et al. (1977), who interpreted it as representing a base camp/village. Moffat and Houston (1986:75) found this site to be over six times larger (25,950 m^2) than the 4,160 m^2 reported by Roper et al. (1977). Testing involved cutbank examinations and the hand excavation of four units. One unit was excavated to 1 m bs, whereas the other three were excavated to 40–50 cm bs. Materials were found to a depth of at least 70 cm, and three flakes were found at 80–92 cm bs in a probable paleosol in the cutbank. In the deepest unit, artifacts were likewise found to at least 100 cm bs. Recovered artifacts included six grog-tempered plain sherds (20–40 cm bs), four Gary Contracting Stemmed points, one Cupp Corner Notched point, one Rice Side Notched point, one Crisp Ovate arrowpoint or preform, and two Scallorn arrowpoints. At a minimum, a Late Woodland occupation zone could be defined at the base of the plow zone. Although deeper deposits may not have been examined in the cutbank, Moffat and Houston (1986:86) commented that "Earlier Archaic occupations may be present in deeply buried contexts" at 23CE255. This site was recommended as eligible for the NRHP.

Site 23CE256 was also recorded by Roper et al. (1977), who defined it as measuring about 2,000 m^2. Moffat and Houston (1986:87) found the site to be a

very extensive lithic scatter measuring 55,200 m^2. Four units were hand excavated to depths of 30–50 cm bs. Relatively few artifacts were recovered from these units, although several artifacts were present in sub-plow-zone contexts. One Late Archaic Stone Square Stemmed and two Woodland points, including a Rice Side Notched point, were found on the surface of 23CE256. The site was not being impacted by cutbank erosion. This site was not recommended as eligible for the NRHP.

Testing at site 23CE401 involved the excavation of two units and examination of a cutbank profile measuring 3.6 m in length and 1.4 m in depth. The units were dug to maximum depths of 40 cm bs and 70 cm bs. Artifacts occurred in all levels of the two units; in the deeper unit, most materials were concentrated at 30–60 cm bs. In this unit, a Scallorn arrowpoint was found at 40 cm bs, scattered charcoal was abundant at 30–50 cm bs, and an unusually large quantity of burned sandstone and limestone was found at 40–50 cm bs. In the shallower unit, in situ pottery was found at 20–40 cm bs and a concentration of burned sandstone was evident at the base of Level 4, the bottom of the unit. The cleared cutbank profile showed chipped-stone debris, one sherd, burned rock, and fragments of charcoal distributed to a depth of 98 cm bs. An Early/Middle Woodland Langtry point was found at 50 cm bs in the cutbank profile. Overall, 14 diagnostic projectile points were found at the site, documenting utilization during the Late Archaic, Early/Middle Woodland, Late Woodland, and Mississippian periods. This site was recommended as eligible for the NRHP.

Testing at site 23CE403 involved piece plotting a small amount of surface debris and the excavation of four 1-x-1-m units to maximum depths of 40–50 cm bs. A single diagnostic hafted biface, a Gary Contracting Stemmed point, was collected from this site. Although 23CE403 occurs on an outside bend of the river and was being actively eroded, Moffat and Houston (1986:106–108) do not mention any cutbank examinations. Artifacts, including burned sandstone, were found in sub-plow-zone contexts, but artifact densities were relatively low, and this site was not considered to be eligible for the NRHP.

Sites 23CE405, 23CE406, and 23CE408 are among a cluster of sites located a little more than 1 km downstream from the Big Eddy site near the confluence of Stockton Branch and the Sac River. At 23CE405, surface artifacts were piece plotted, and a single 2-x-2-m unit was excavated to a depth of only 30 cm bs, resulting in the recovery of a small quantity of cultural debris. This site was not recommended as eligible for the NRHP.

Site 23CE406 included a mound determined to be a spoil pile. Surface debris density was estimated as light to moderate, with the highest density outside the sloughing easement. Two units were hand excavated: a 2-x-2-m unit to 100 cm bs and a 1-x-1-m unit to 80 cm bs. The densest artifact zone was at 60–70 cm bs in the larger unit atop the spoil pile and at 50–60 cm bs in the smaller unit off the spoil pile. The dense zone at 50–70 cm bs coincides with a possible paleosol that appears to date to the Late Woodland period. Collected diagnostic bifaces included six Late Woodland Rice Side Notched points and a Madison Triangular arrowpoint. This site was recommended as eligible for the NRHP.

Site 23CE408 occurred on the outer bend of Stockton Branch. Two loci were defined based on the surface evidence. Testing at 23CE408 involved a gridded surface collection and the excavation of four 1-x-1-m units. One unit was dug to 100 cm within Locus A, whereas the other three were excavated only to 40 cm bs (two in Locus A and one in Locus B). In the deepest unit, artifacts were found at 10–90 cm bs, with the highest densities at 60–80 cm bs. Moffat and Houston (1986:122) also reported the recovery of an obsidian thinning flake from Level 8 (70–80 cm). Only two diagnostic projectile points were recovered from the site (both from Locus A). They were a possible Early Archaic Jakie Stemmed point from the surface and a Late Woodland Rice Side Notched point from Level 1 in one of the shallow units. This site was recommended as eligible for the NRHP.

Site 23CE410 was found by shovel testing on a high terrace adjacent to Silver Creek. Survey and limited shovel probing resulted in the recovery of 148 artifacts. Four units were hand excavated to depths of 40–60 cm bs. Artifacts occurred in all levels of all units, with the highest densities in Level 2 of all units. Diagnostic projectile points recovered consisted of two Smith Basal Notched points from Levels 1 and 4, a Gary Contracting Stemmed point from Level 3, and a Kings Corner Notched point from a screened shovel probe in the center of the site. At least one of the Smith Basal Notched points appears to be a Stone Square Stemmed or Etley-like point, the Gary is Waubesa-like and may be a large Langtry point, and the Kings is probably a Late Archaic point type, being somewhat unlike the typical

Kings Corner Notched. This site was recommended as eligible for the NRHP.

Site 23CE412 is situated at the northeast corner of the modern confluence of Bear Creek and the Sac River. It was discovered during a canoe survey. Two 1-x-1-m units were excavated in the eastern part of 23CE412. One was excavated to 50 cm bs and the other to only 30 cm bs. Two surface collections were obtained. One Reed Side Notched and two Scallorn Corner Notched arrowpoints were recovered. Although it was being eroded by both the Sac River and Bear Creek, Moffat and Houston (1986) do not discuss the results of examining the steep cutbanks in this locality; however, CAR staff and several collectors have observed deeply buried materials eroding from this site. Two local collectors report finding Dalton, Graham Cave, and Williams points from the site (Dan Long and A. Clark Montgomery, personal communication 1998). The eastern part of 23CE412 was not considered eligible for the NRHP, but testing was recommended for the previously unrecorded western part of the site.

Sites 23CE417 and 23CE418 occur side-by-side along the right bank of the Sac River about 2 km upstream from the Big Eddy site. Five units were excavated at 23CE417 to depths of 30–50 cm, and three units were excavated to depths of 30–60 cm at 23CE418. At site 23CE417, artifacts were present in all levels. Two projectile points, one identified as a Gary Contracting Stemmed and the other as a Langtry Contracting Stemmed, were recovered from 23CE417. The supposed Gary (which also appears to be a Langtry) was found in association with a Middle Woodland dentate-stamped sherd in sub-plow-zone context within Level 4 of the same unit. At site 23CE418, artifacts were recovered from all but Level 6 of the deepest unit. These included a badly eroded limestone-tempered body sherd from Level 2 of one unit and a Scallorn arrowpoint from Level 4 (i.e., below the plow zone) of another unit. No information is provided about the adjacent cutbank for either site. Site 23CE417 was recommended as eligible for the NRHP, whereas 23CE418 was not.

Sites 23CE419 and 23CE420 occur adjacent to one another on "knolls" almost 2 km below Stockton Dam on the right side of the Sac River. Based on the height of these knolls and the character of the gravelly soils, they appear to be on a single Pleistocene terrace that has been bisected by a small intermittent stream. Thirty-nine shovel probes and two units were excavated at 23CE419, and 44 probes and one unit were excavated at 23CE420. All three units were dug to a maximum depth of 50 cm, with artifacts in all levels. Both sites apparently had never been plowed. At 23CE419, 15 "sand or grit tempered" sherds were recovered from Levels 2 and 3 of one unit. Numerous projectile-point fragments were also recovered, but only one base of a Langtry Contracting Stemmed point could be identified. The pottery, which included three rim sherds possibly from three different vessels, was assigned to the Late Woodland period. Although no ceramics were found at 23CE420, the bases of two Rice Side Notched points were recovered. In addition, a pit feature and the probable edge of another feature were found within the single 2-x-2-m unit excavated. Both 23CE419 and 23CE420 were considered eligible for the NRHP.

Testing at site 23CE421 involved intensive controlled surface collecting and the excavation of four 1-x-1-m units. The units were excavated to maximum depths of 40–60 cm. Few artifacts were found in the units, but the large surface collection contained portions of 15 projectile points assignable to six different Woodland types: Langtry Stemmed, Gary Stemmed, Cupp Corner Notched, Rice Side Notched, Scallorn Corner Notched arrowpoints, and one point comparable to Kay's (1982e:435) Category 16 from Rodgers Shelter. A. Clark Montgomery reports finding a bevelled Breckenridge point (Dalton variant) at this site (personal communication 1998). Although the Sac River apparently was eroding the northeast end of the site, Moffat and Houston (1986) do not mention any cutbank examination. This site was not recommended as eligible for the NRHP.

Environmental Systems Analysis Testing Program

ESA tested 18 sites below Stockton Dam during the spring and summer of 1986. These consisted of one site (23CE52) previously recorded in 1962, 12 sites recorded in 1976 (23CE226–227, 23CE229–230, 23CE238–239, 23CE242, 23CE245, 23CE253, 23CE258, 23CE262–263), and five sites that were newly recorded by Schmits (1988): 23CE409 and 23CE423–427, which includes the Big Eddy site itself. Testing results for 17 sites (not including the Big Eddy site) are briefly reviewed below; the 1986 Big Eddy testing will be discussed in Chapter 4. Of the 18 tested sites, five were considered eligible for the NRHP, five were not, and no further work was

recommended for eight sites of which only small portions were within the easements. At these eight sites, Schmits (1988) argued for additional testing in the larger portions outside the easement before making NRHP recommendations.

Both 23CE52 and nearby 23CE242 are located on low terraces bordering Horseshoe Bend, a large meander loop of the Sac River about 1 km above Caplinger Mills. Testing at the two sites involved the excavation of four units and five units, respectively. At 23CE52, units were excavated to a maximum depth of 80 cm bs. Artifacts were restricted either to the plow zone or to an AB horizon that extended no deeper than 40 cm bs. Two Late Archaic points (a possible Afton Corner Notched and a Smith Basal Notched/Stone Square Stemmed), an Early/Middle Woodland point, and a possible Late Woodland arrowpoint were recovered from site 23CE52. At 23CE242, testing also demonstrated that artifacts were confined mainly to the upper 30 cm of deposits, although some materials were found in one unit to a depth of 60 cm. A probable hearth feature containing charcoal, burned earth, fire-cracked rock, and debitage also was found in this unit at 45–55 cm bs. A charcoal sample yielded a radiocarbon date of 1150 ± 60 B.P. (Schmits 1988:93). Two Scallorn arrowpoints were found on the surface of the site, supporting a Late Woodland cultural affiliation for the sampled deposits. Evidence from the nearby cutbank, if exposed at all, is not presented. The NRHP eligibility of 23CE52 was not given, but Schmits (1988) recommended that 23CE242 not be considered eligible despite the presence of intact deposits and a feature.

Site 23CE226 is situated on a low terrace along a former channel of the Sac River. In addition to undertaking a surface collection, five 1-x-1-m units were excavated to a depth of 80 cm bs. All of the artifacts were confined to the upper 40 cm bs. An ash-laden stain representing a possible hearth was found at 20 cm bs. It contained a light scatter of carbonized wood and nutshell, along with burned earth and a projectile-point fragment. The hearth and associated expanding-stemmed, straight-based point fragment are tentatively assigned to the Late Archaic period (Schmits 1988:68). Other artifacts from the site include two small dart points and a drill that also may date to the Late Archaic period. This site was recommended as NRHP eligible, but it was not being affected by erosion from power releases.

Sites 23CE227 and 23CE423 are located on nearby terraces in the vicinity of the old Highway J bridge and road to the east of the new Highway J bridge and road. A surface collection was obtained and 10 1-x-1-m units were excavated to depths of 80–100 cm bs at 23CE227. Five units contained material down to 20 cm bs only, whereas one unit contained material to 40 cm bs, three contained material to 60 cm bs, and one contained material to 90 cm bs. The artifact assemblage, along with artifacts in a private collection, indicate primary utilization of this site during the Late Archaic period, although a Middle Archaic component is also suggested by Schmits (1988:72). A single Scallorn arrowpoint fragment also points to a Late Woodland and/or Mississippian component. Possible "midden staining is also indicated by the dark brown color of the upper soil horizon" (Schmits 1988:73–74). Despite the findings, NRHP eligibility was not determined based on the fact that only a small portion of this site occurs within the easement.

Testing at 23CE423 involved surface collecting and the excavation of three 1-x-1-m units to a maximum depth of 80 cm bs. Artifacts were apparently restricted to the upper 40 cm bs of the excavated deposits. No diagnostic artifacts were recovered and artifact density was deemed low. Although materials were found in sub-plow-zone contexts at this site, it was not considered eligible for the NRHP.

Sites 23CE229 and 23CE230 were defined on a low terrace bisected by Highway J, where the modern bridge crosses the Sac River. Site 23CE229 occurs on the west side of the road and 23CE230 is on the east side. Roper et al. (1977) previously recovered three Langtry Contracting Stemmed points from 23CE229 but no diagnostics from 23CE230. At 23CE229, Schmits (1988) obtained a surface collection and excavated eight test units to depths of 80–100 cm bs. Four units contained artifacts to 40 cm bs, three contained artifacts to 60 cm bs, and one was devoid of artifacts. A single corner-notched point fragment, considered to be a Woodland form, was recovered. Most of the debris was found in an area 100 m or more from the current river bank. The site was recommended as eligible for the NRHP, but impacts to the site were considered negligible. At 23CE230, Schmits undertook a surface survey

and excavated seven test units to maximum depths of 80–100 cm bs. Artifacts were found in the upper 50 cm bs, overlain by about 15–30 cm of disturbed fill. In one unit, a few flakes were found at 70–80 cm bs, perhaps representing a more deeply buried component. Schmits (1988:81) concluded that "the types of artifacts, artifact density and depth of deposits encountered at both sites" likely indicate that 23CE229 and 23CE230 are parts of the same site. Even so, no further work was recommended for that portion of 23CE230 within the sloughing easement.

Sites 23CE238 and 23CE239 are located on a prominent terrace along the outer edge of a large meander of the Sac River, just above its confluence with Alder Branch. Ten units were excavated at 23CE238 to maximum depths of 80 cm bs, and five units were excavated at 23CE239 to maximum depths of 80–100 cm bs. During the 1986 survey, a Langtry point and a grit-tempered body sherd were recovered from the surface of 23CE238. As a result of the excavations, at least four Late Archaic, Woodland, and possibly Mississippian components can be recognized. The Archaic component seemed to be restricted to the east half of the site, mainly at a depth of 30–50 cm bs. Two Late Archaic points were recovered, including a Smith-like point from 45 cm bs in one unit. Woodland components, represented by a Langtry Contracting Stemmed point, a Steuben-like point, a Kings Corner Notched point, two Scallorn arrowpoints, and grit-tempered pottery, were considered to be dispersed throughout the site, although these components apparently were confined to the upper 20 cm in association with midden-stained deposits. A single point tentatively identified as a Mississippian Table Rock Pointed Stemmed also is mentioned by Schmits (1988:86).

As should be expected, Schmits found similar archaeological deposits at nearby 23CE239. Artifacts were found in three units to a depth of 30 cm bs, in one unit to 50 cm bs, and in one unit to 70 cm bs. Three units contained intact sub-plow-zone deposits. Fewer diagnostics were found at 23CE239, but the collections and excavations likewise point to the presence of stratified Late Archaic and Woodland components. Although 23CE238 was recommended as being eligible for the NRHP, 23CE239 was not.

Site 23CE245 is located on a low terrace about 400 m southeast of the Horseshoe Bend meander of the Sac River. Roper et al. (1977) originally reported the site and found three Scallorn arrowpoints, a Cahokia Notched arrowpoint, and a Madison Triangular arrowpoint on the surface. A surface collection was obtained and four 1-x-1-m units were excavated to a maximum depth of 80 cm bs in 1986 by ESA. Only a small number of artifacts were recovered during the investigations at 23CE245, and it was not considered eligible for the NRHP.

Site 23CE253 is located on a low terrace just above the confluence of the Sac River and Silver Creek. Roper et al. (1977) originally recovered a large quantity of debris from this site. Thirteen projectile points include two Big Sandy Side Notched points, a Smith Basal Notched, an Afton Corner Notched, a possible Etley, three large corner-notched points, a Scallorn, and two unidentified specimens. In addition to these, Roper et al. (1977) reported finding one "lobed" point and a lanceolate point from unspecified contexts. Testing of the small portion of the site within the sloughing easement in 1986 involved excavation of five 1-x-1-m units to a maximum depth of 80 cm. Artifacts were confined to the upper 40 cm of four of the five units; the other unit was sterile. A single Late Archaic Stone Square Stemmed point was recovered in 1986 at a depth of 10 cm bs in one of the units. The portion of the site within the sloughing easement was not considered eligible for the NRHP.

Site 23CE258 is situated on a prominent terrace at the base of the bluffs about 2.5 km east of the Highway J bridge. Roper et al. (1977) originally defined 23CE258 as a large Late Archaic and Woodland multicomponent site. The collection contained one Cupp Corner Notched point and two Scallorn arrowpoints. Testing in 1986 involved the excavation of 12 1-x-1-m units to a maximum depth of 90 cm bs. Artifacts were found in the upper 30 cm of only three of the test units. No diagnostics were recovered during the testing phase. Only the small portion of the site tested in 1986 was considered not eligible for the NRHP.

Site 23CE262, located on the opposite side (left bank) of the Sac River from 23CE238 and 23CE239, was originally defined based on the recovery of a single Early Archaic Rice Lobed point on a gravel bar. Three units were excavated nearby in 1986, but nothing was found. The point is assumed to have been a redeposited artifact displaced from a site upstream. Site 23CE262 was not considered eligible for the NRHP.

Site 23CE263 is located on a low terrace on Keith Island and borders the outside bend of a me-

ander of the Sac River. The site was defined by Roper et al. (1977) based on a single find. Testing involved surface collecting and the excavation of four 1-x-1-m units to a depth of 80 cm. A light scatter was found on the surface, and artifacts were limited to the plow zone within the four excavated units. The only diagnostic is an arrowpoint fragment that could not be classified according to type. Site 23CE263 was not considered eligible for the NRHP.

Site 23CE409 was originally identified by Moffat and Houston (1986). It occurs just below the confluence of the Sac River and Silver Creek. During the original survey, a large quantity of material was found, including a Stone Square Stemmed point and a Langtry Contracting Stemmed point. Testing involved the excavation of six units to maximum depths of 80–140 cm bs. A dense scatter of material was found in four units at 20–40 cm bs; lighter scatters of material were found in another unit at 40–60 cm bs and in still another at 40–130 cm bs. Five identifiable projectile points were recovered: a Scallorn arrowpoint, a heavily resharpened Smith Basal Notched point, a Langtry point, and two corner-notched points, one of which is a Kings Corner Notched. The variety of other tools and the density of debris at this site suggested it was a Late Archaic base camp that was later utilized by Woodland groups. The site was considered NRHP eligible.

Site 23CE425 is a relatively large site located on the right bank of Alder Branch a short distance upstream from its confluence with the Sac River. Testing at 23CE425 involved a pedestrian survey and the excavation of eight units to a maximum depth of 80 cm. A relatively small number of artifacts was recovered from the upper 40 cm of six units; most occurred at 20–40 cm bs immediately below the plow zone. Portions of two dart points were recovered from the surface. One is a large stemmed point reworked into an end scraper, and the other is a shallow side-notched point with a concave base. It "is similar to the Jakie Stemmed type which may indicate a Middle Archaic cultural affiliation" (Schmits 1988:110). In any regard, the portion of the site within the sloughing easement was not considered to be eligible for the NRHP.

Site 23CE427 was defined by cultural deposits eroding out at 3 m bs along a cutbank of Bear Creek about 600 m above its confluence with the Sac River. Two deep test units were excavated. An entire 2-x-2-m unit was excavated to 3 m, then a 1-x-1-m quadrant was continued to 3.5 m. The second unit (1 x 2 m) was excavated to 3 m. A light scatter of flakes and an Afton point were found at 160–170 cm bs in the large test unit and a "more substantial component," represented by a "dense concentration...of chipped and ground stone tools, burnt rock and lithic manufacturing debris" was found in both units at 260–270 cm bs (Schmits 1988:118). A probable hearth also was defined in the cutbank at 240–260 cm bs, but most of it had been destroyed by erosion. Wood charcoal from this feature yielded a radiocarbon date of 4450 ± 90 B.P., indicating that the artifacts found at 260–270 cm bs are probably Late Archaic or slightly earlier. However, the base of a Jakie Stemmed point was found in the cutbank in association with these deposits, suggesting some of the cutbank deposits may be as much as 7,000–8,000 years old. Site 23CE427 was recommended as eligible for the NRHP, and protective measures or data recovery were urged by Schmits (1988:122) to mitigate the severe ongoing impacts to this site.

Historic Preservation Associates Testing Results

It had been repeatedly argued by previous investigators that the relatively limited number of Paleoindian, Early Archaic, and Middle Archaic sites in the lower Sac River valley could be attributed to alluvial burial and inaccessibility to pedestrian surface surveys (Moffat and Houston 1986; Perttula and Purrington 1988; Roper et al. 1977). The 1976 excavations at the Montgomery site, as well as the accumulating evidence from testing projects, cutbank surveys, and Ziegler's (1994) field survey in 1989 resulted in the increasing documentation of deeply buried archaeological deposits. As a consequence, subsequent testing by HPA within sloughing and flowage easements below Stockton Dam involved consistently deeper excavations than had been undertaken previously.

Klinger et al. (1992) tested seven sites or portions thereof in flowage easements along the Sac River below Caplinger Mills (23CE46C, 23CE439, 23CE442, 23CE444, 23CE446, 23SR291, and 23SR1067). Six of these sites were discovered, or rediscovered in the case of 23CE46C, during the unreported ESA surveys in 1986 and 1987. The other site, 23SR291, was located by UM archaeologists in 1975 and revisited by ESA in 1987. An eighth site, 23CE440, is listed in the title of the report for this project, but it was not tested because access was denied by the landowner.

Several of these sites reportedly had buried components, and at least two were believed to have deeply buried components eroding from the cutbanks: 23CE439 (note that the Kansas City District included 23CE437 and 23CE438 with 23CE439 because of their proximity) had purported buried components at 2.9–3.1 m and 4.5 m, and 23CE446 was reported to have buried deposits at 4 m. Other sites, such as 23CE442 and 23CE444, also were observed to have buried deposits at 2.2–2.3 m below the cutbank surfaces. Prior to the work by HPA, only one site (23SR1067) had previously identified prehistoric components (Late Archaic and Early Woodland).

A substantial amount of work was undertaken at the seven sites, including controlled surface collecting and/or piece plotting of surface debris, shovel probing of surface deposits, hand excavations of 40 test units (mostly 1 x 2 m in size with a few that were 1 x 1 m), and relatively deep posthole excavations below the bases of hand-excavated units (typically 50 cm below the base of the final 10-cm unit level). The shovel probing, unit excavations, and deep posthole tests amounted to the removal of 63.54 m^3 of sediments. A considerable amount of data are presented. Unfortunately, only three artifacts (all Late Paleoindian) are illustrated, and a concerted effort to understand the geomorphology of these sites is lacking. The results of their work point to a considerable amount of geomorphic complexity in the area.

In Unit 1 at 43CE46C, HPA reported finding artifacts between the surface and 90 cm bs and again between 130 and 160 cm bs possibly in association with a paleosol. The large surface collection included a Late Archaic Table Rock Stemmed point, several other probable Archaic point fragments, a Late Woodland/Early Mississippian Scallorn arrowpoint, and a Mississippian Table Rock Pointed Stem point. The other two units at this site produced materials to a maximum depth of 70 cm bs. This site was recommended as eligible for the NRHP.

Eight units were excavated at 23CE439, and a large surface collection was amassed. The surface collection produced a Scallorn arrowpoint, and Unit 4 produced a point identified as a Middle Woodland Gibson in Level 4 (30–40 cm bs). Most artifacts in Unit 4 occurred at 30–60 cm bs. One other unit (Unit 5) also produced artifacts in sub-plow-zone contexts down to 80 cm bs. Although not identified as such, a possible paleosol also may have been present in this unit at 117 cm bs, but such deposits were only examined by a posthole test. Deeper excavations were undertaken at 260–290 cm bs (posthole test to 340 cm bs) and 440–460 cm bs (posthole test to 510 cm bs) in two units following removal of overlying sediments by a backhoe. These were placed where 23CE427 had been defined as having deposits at 300 cm below surface and 23CE438 was reported to have deposits at 450 cm bs. No artifacts were found during these deeper excavations. This site was not recommended as eligible for the NRHP.

Three units were hand-excavated at 23CE442, a site where deposits were reported to occur at 220 cm bs by Donohue and Schmits (cited in Klinger et al. 1992:23). Hand excavations were undertaken in 10-cm levels in Units 1, 2, and 3 at 200–310 cm bs, 176–250 cm bs, and 195–240 cm bs, respectively. In Unit 1, charcoal and a modest number of artifacts were found at 210–300 cm bs. Artifacts were most concentrated at 250–280 cm bs, and they consisted of an abundance of charcoal, 36 grit-tempered pottery sherds, and 47 other artifacts. A few artifacts also were found in Unit 2 at 180–190 cm bs and again at 230–240 cm bs. This site was recommended as eligible for the NRHP.

A considerable amount of effort was undertaken at 23CE444 and 23CE446, both of which also reportedly had buried components. At site 23CE444, the investigations included the excavation of 39 shovel probes, 14 posthole tests, and nine 1-x-2-m units. Most of the units at 23CE444 demonstrated an abundance of debris in the upper 30–40 cm. A Scallorn arrowpoint was found on the surface, and another arrowpoint was found at 20–30 cm bs in Unit 4. Secondary peaks in artifact abundance, including some charcoal, also were noted at 50–70 cm bs in two units (Unit 2 and Unit 4), and the densest amount of debris was found in Unit 9 at 50–90 cm bs. In addition to these findings, three possible postmolds were identified at 60 cm bs in adjacent Units 4 and 5. Based on the soil descriptions, profiles, and peaks in artifact densities, it seems likely that a paleosol was present at 60–80 cm bs in most of the units.

Deeper excavations also were undertaken at 23CE444 in three units (Units 7–9). In Unit 7, which was hand excavated at 140–210 cm bs (posthole test to 260 cm bs), artifacts were recovered at 140–200 cm, and another possible paleosol may have been present at 156–190 cm. Hand excavations were undertaken in Unit 8 at 160–250 cm bs (post-

hole test to 300 cm bs), resulting in the recovery of 31 items at 180–240 cm bs. Most of the artifacts were concentrated at 200–220 cm bs; they included a stemmed dart-point fragment that was not identified. In Unit 9, hand excavations were undertaken at 400–420 cm bs, following removal of deposits between 100 cm bs (base of upper excavations) and 400 cm. Nothing was found in the deeper excavations, although a Dalton point was found out of context in the river below the site. Despite their findings of artifacts, features, and charcoal in subplow-zone contexts, Klinger et al. (1992:93) did not recommend 23CE444 as eligible for the NRHP, stating that "no dateable contexts have been found at the site and none are likely to exist. There is also no indication that floral or faunal material or human remains have been preserved at the site."

Investigations at site 23CE446 included the excavation of 45 shovel probes and eight 1-x-2-m units. Donohue and Schmits (cited in Klinger et al. 1992:24) had reported the presence of charcoal and burned clay at 400 cm bs, perhaps representing a cultural component. Relatively few artifacts were found on the surface of this site or in a grid of shovel probes excavated to sample the upper deposits. Nonetheless, a Dalton point was found at the base of the river bank. Excavations of 10-cm levels in the upper deposits were limited to the top 30–40 cm bs in six units and 50–60 cm bs in two units. Unit 6, the only unit excavated to 60 cm bs, contained the most artifacts. In this unit, artifacts were concentrated at 40–50 cm bs and a fragment of a terminal Paleoindian/Early Archaic Beaver Lake point was found in Level 6 (50–60 cm bs). Deeper excavations were undertaken in one unit (Unit 3). During backhoe excavations from 40–400 cm bs, a burned tree stump consisting of oxidized clay and charcoal was found at 270 cm bs. Hand excavations of 10-cm levels at 400–420 cm bs (posthole test to 460 cm bs) did not result in the recovery of cultural material. A piece of mussel shell and 16 pieces of charcoal are listed in the table of artifacts for this site (Klinger et al. 1992:Table 14). Despite the presence of this material, site 23CE446 was not considered eligible for the same reasons presented for 23CE444.

Limited investigations were undertaken at 23SR291, located on a wooded slope near Rockhouse Cave. Ten postholes and one 1-x-2-m unit were excavated. The single unit was hand excavated in 10-cm levels to 90 cm bs and posthole tested to 220 cm bs. The vast majority of recovered material was historic. The remains were found primarily in the upper 90 cm bs, although historic material occurred at least as deep as 150 cm bs.

Site 23SR1067, the seventh site tested by Klinger et al. (1992), was the scene of relatively intensive investigations. Twenty-five postholes, seven 1-x-2-m units, and one 1-x-1-m unit were excavated. Units 1–5 were dug in 10-cm levels to depths of 120 cm bs, 160 cm bs, 120 cm bs, 130 cm bs, and 180 cm bs, respectively. Excavations in Units 1, 2, and 8 began from the surface, whereas those in Units 3–7 began after 40–50 cm were removed by a backhoe. Artifacts were present in Unit 1 to a depth of 100 cm bs, with the greatest concentration at 70–90 cm bs. In Unit 2, artifacts were found at 20–140 cm bs and again at 200–220 cm bs, with the greatest concentration at 110–130 cm bs. Artifacts were found in Unit 3 down to 100 cm bs. In Unit 4, a dense concentration of artifacts was evident at 80–90 cm bs, and included a Late Archaic Smith Basal Notched dart point/knife. Artifacts were meager (n=32) in Unit 5, but over half were found at 140–160 cm bs. Of the remaining three units, Levels 1 and 2 of Unit 8 stood out as having a great number of artifacts; these included one body sherd of sand-tempered pottery. This site was recommended as eligible for the NRHP.

Discussion of Previous Investigations

To date, all 1,506 acres of the sloughing easement have been surveyed, but the 48 acres of flowage easement have not (Ziegler 1994:18). As of 1994, a total of 66 sites (not including 23CE499 and 23CE500 identified recently by Ray) had been recorded within the present sloughing easements, including 60 that were recorded or resurveyed by professional archaeologists. An exceptional number of these sites, 52 or almost 80%, have been tested. Of those tested, 20 have been deemed eligible to the National Register of Historic Places (Ziegler 1994:Table 3.1). Identified components are listed in Table 1.2 (per Ziegler 1994:Table 3.2), excluding those identified as Dalton/Early Archaic (n=1), Early Archaic/Middle Archaic (n=2), Late Archaic/Woodland (n=1), Undifferentiated Woodland (n=16), Late Woodland/Mississippian (n=4), Unknown Prehistoric (n=13), and Historic Euroamerican (n=6).

The information presented in Table 1.2 should only be viewed in a general way and perhaps as being most representative of late Holocene (Late Ar-

Table 1.2. Numbers of Components Per 1,000 Years by Prehistoric Period.

Period	Temporal Duration	Number of Components	N/1,000 Years
Late Paleoindian (Dalton)	10,500–10,000 B.P.	2	4.0
Early Archaic	10,000–8000 B.P.	3	1.5
Middle Archaic	8000–5500 B.P.	6	2.4
Late Archaic	5000–3000 B.P.	17	6.8
Early Woodland	3000–2200 B.P.	1	1.2
Middle Woodland	2200–1500 B.P.	3	4.3
Late Woodland	1500–1000 B.P.	15	30.0
Mississippian	1000–300 B.P.	2	2.9

chaic–Mississippian) component frequencies. Even within those late Holocene periods, however, there are numerous potential errors that diminish the relevance of these data. First, some of the projectile points have perhaps been misidentified, and, therefore, component assignments should be taken with a "grain of salt." For example, Pertulla and Purrington (1988:93) reclassified the Middle Archaic Big Sandy identified by Roper et al. (1977) for site 23CE235 as a corner-notched Late Archaic type, and in this report the identifications of several previously excavated points have been questioned based on drawings and figures. Unfortunately, Klinger et al. (1992) only illustrate three points, making it impossible to evaluate the accuracy of the vast majority of their identifications. On the other hand, abundant line drawings are presented by Moffat and Houston (1986), even of many different types of tools, and excellent photographs are presented by Schmits (1988), making it relatively easy to evaluate their identifications. In any regard, accurate identification of many of these artifacts can only be accomplished by the establishment of a more definitive typology and, when necessary, examination of the original specimens.

Second, many of the specified point types have not been adequately dated, and some perhaps crosscut the somewhat arbitrary panregional temporal boundaries established for these periods. In other words, some assumptions about point-period associations may be partly or entirely incorrect, particularly at the regional or local level. For example, Scallorn arrowpoints probably were manufactured in this region during Early Mississippian times as well as during the Late Woodland period. Yet, all Scallorn points were considered diagnostic of the Late Woodland period by the authors of previous reports. The number of sites per 1,000 years for the Early and Middle Woodland periods is also seemingly too low. It can be attributed in part to the fact that we simply do not know what an Early Woodland site in the lower Sac River valley should contain. Many of the sites do contain Gary and Langtry points, and these should date to earlier Woodland times, but they have been classified previously as generic Woodland types, thus accounting for the large number of Undifferentiated Woodland components.

Ceramics are temporally distinctive due to relatively rapid changes in technology and the ease of modifying and decorating vessels when the clay is plastic. Thus, pottery is typically more useful than projectile points in developing and refining local and regional chronologies during those periods when ceramics were produced. Unfortunately, pottery does not appear to be well preserved at sites in the Sac River valley, nor in many parts of the Ozarks. Still, an intriguing diversity of temper types is described for several sites that were tested. Radiocarbon dates on such artifacts are sorely needed if more realistic local and regional sequences are to be developed and refined. The testing work by Schmits (1988) is the only project to produce radiocarbon dates (n=2) on features and artifacts. This is quite unfortunate given the depth of excavations and the identification of several buried deposits at some sites tested by HPA.

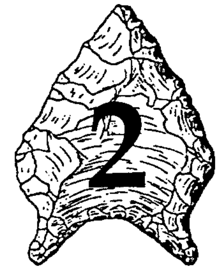
The above descriptions of testing results serve to illustrate two key interrelated points. First, much of what has been done in the past can be considered relatively surficial. That is, much of the previous testing work barely penetrated the surfaces of

many sites, and potentially buried geomorphic surfaces have not been adequately examined, much less identified. Second, little of the Archaic record during the early and middle Holocene has been documented in the lower Sac River valley. Testing has shown that many Archaic and earlier components are probably deeply buried in late Pleistocene and early-middle Holocene landforms in the lower Sac River floodplain. Clearly, the vast majority of previous test excavations, especially those undertaken relatively early by CAR, ARG, and ESA, were conducted in late Holocene terrace fills. In fact, much of the floodplain appears to be covered with a mantle of late Holocene fill ranging from about 1 m to 3 m or more in thickness.

It is readily apparent that a major void in our ability to provide adequate determinations of eligibility for sites below the Stockton Dam stems from our presently poor overall knowledge of geomorphology in the lower Sac River valley. The 1990–1991 work by HPA archaeologists represented the first substantial testing of some of the deeply buried deposits along the lower Sac River channel. Virtually all of the seven sites examined by Klinger et al. (1992), for example, proved to have artifact-bearing sub-plow-zone deposits. However, much more is probably present at a few of the sites, which may have complex deposits marked by lateral as well as vertical accretions of terrace fills. Clearly, recommendations for sites such as 23CE412, 23CE421, 23CE439, 23CE444, and 23CE446 should be reevaluated.

During the course of re-examining the four sites that were originally designated as priority sites for mitigation (23CE238, 23CE255, 23CE401, and 23CE426), cutbank examinations showed that three had buried components that had not been identified before (Lopinot and Yelton 1996). These were discovered during periods of 2–4 hours at each site. At Big Eddy, the richest deposit at the site—the Late Paleoindian component—was not identified during testing (see Chapter 4). The discovery of deeply buried deposits at three of the four sites reflects the fact that new sites and buried deposits will continue to be found along the lower Sac River and near the mouths of its tributaries as long as cutbank erosion continues. It is incumbent, therefore, that the USACOE supports the continuation of periodic cutbank surveys and the implementation of intensive testing programs that include thorough geomorphic analyses, as well as mitigation of archaeological sites. Sites below Stockton Dam can potentially yield extremely important information on cultural chronology and changing human adaptations since the late Pleistocene. Furthermore, the lower Sac River valley is bracketed by a reservoir both upstream (Stockton Lake) and downstream (Truman Reservoir), making it the only major floodplain left in the area.

ENVIRONMENTAL CONTEXT



Neal H. Lopinot and Jack H. Ray

This chapter provides contextual information about environmental conditions relevant to the Big Eddy site and the region, both past and present. This includes information on physiography, geology, soils, paleoecology, presettlement vegetation, and fauna. Such data are essential if we are to achieve a basic understanding of site use and changing human population dynamics and adaptation in the region.

PHYSIOGRAPHY AND GEOLOGY

The Big Eddy site is located on the west flank of the Ozark Province (Ozark Plateaus) in southwest Missouri (Figure 2.1). The physiographic subprovince in which the site is located has been referred to as the Springfield Plain (Sauer 1920) and the Springfield Plateau (Bretz 1965; Fenneman 1938). Unlike the more rugged Salem Plateau to the east, the general topography of the Springfield Plateau consists of broad, gently rolling uplands with relatively minor relief. The landscape of the Springfield Plateau, however, becomes more rugged near major river valleys with steep slopes and bluffs. The floors of the river valleys consist of alluvial floodplains and terraces, some of which are quite broad.

All but the extreme northwest corner of Cedar County is drained by the Sac River and its principal tributary streams (Bear, Little Sac, Cedar, and Horse creeks). The Sac River is a major southern tributary of the Osage River, which empties into the Missouri River in central Missouri. The mean annual flow of the Sac River at Stockton prior to dam construction was 986 cfs (cubic feet per second), and it has averaged approximately 1,252 cfs since dam construction (Department of the Interior 1969; Hauck et al. 1997). The downstream portion of the Sac River (below Stockton Dam) exhibits a relatively low gradient (vertical drop in meters or feet per mile) compared to other Ozarks streams. For example, the average gradient of the lower Sac River is approximately 0.5 m (1.6 ft) per mile compared to an average gradient of nearly 1.2 m (4 ft) per mile for the neighboring Pomme de Terre River (Hawksley 1989). Other streams in the Ozarks typically have gradients of 1.2–2.4 m (4–8 ft) per mile or more. In the vicinity of the project area, the lower Sac River valley also exhibits a relatively broad (1 km wide) valley floor, which is two to four times wider than most Ozark river valleys. The lower Sac River adopts a sluggish, strongly meandering regime within this wide valley.

The low gradient, broad floodplain, and sluggish, meandering pattern of the lower Sac River have allowed for the development and preservation of large, thick alluvial formations. The valley configuration creates a slackwater or ponded, rather than scouring, environment during flooding, which results in deposition and rapid accretion of alluvial sediments. Consequently, the potential for deeper and older valley fill dating to at least late Pleistocene times is greater in the Sac River valley than it is for most other Ozark valleys. The oldest alluvial unit containing cultural materials is late Pleistocene to middle Holocene in age and appears to correlate with the Rodgers Shelter Formation defined by Haynes (1976, 1985) and Brakenridge (1981) in the neighboring Pomme de Terre River valley. The youngest alluvial unit in the study area is late Holocene in age and appears to correlate with the Pippins Cemetery Formation (Brakenridge 1981; Haynes 1976, 1985).

The geology of Cedar County is relatively complex with no fewer than 11 mapped rock formations

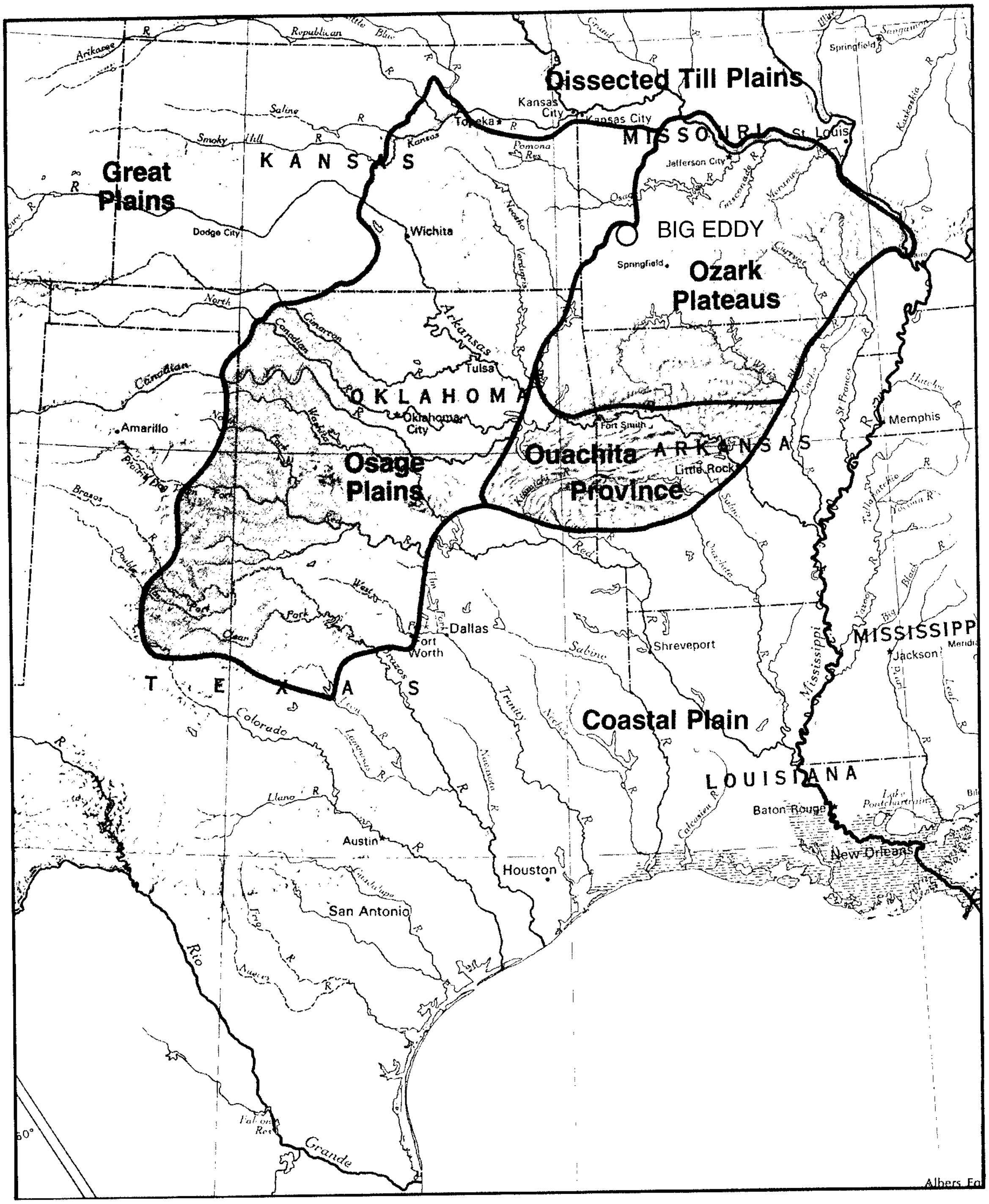


Figure 2.1. Location of the Big Eddy site in relation to physiographic provinces (adapted from Madole et al. 1991).

(Neill 1987) (Figure 2.2). Sandstone-and-shale-dominated Pennsylvanian-aged formations cover most of the western and northeastern portions of the county, whereas limestone-dominated Mississippian-aged formations cover the central and southern portions. Ordovician-aged Jefferson City–Cotter dolomite occurs in localized outcrops along Brush Creek, Turkey Creek, and the Sac River.

The rock formations that outcrop around the Big Eddy site between Stockton Dam and Caplinger Mills contain several lithic resources that were utilized by prehistoric inhabitants. High-quality chert occurs in the Jefferson City–Cotter formation, Chouteau group (Compton-Sedalia formations), and Burlington-Keokuk formation (Ray 1983). Highly rounded, redeposited cobbles of Jefferson City, Chouteau, and Burlington chert also occur in localized conglomerate deposits in the Warner formation. These cherts are found in residual deposits in upland locations and stream deposits in valley-bottom locations. Detailed descriptions of these local chert resources and their distributions within and around the project area are presented in Chapter 9.

Sandstone and siltstone for ground-stone tools such as manos, metates, pitted stones, and abraders are found in the Jefferson City–Cotter, Northview, and Warner formations. The Jefferson City–Cotter formation also contains localized deposits of cottonrock, a fine-grained silty dolomite often used for the manufacture of light-duty grooved axes during Archaic times. Hematite and limonite (iron ore) deposits in the project area are derived from two sources. A pure, high-grade hematite that occurs in tabular nodules is found at or near the contact between Burlington-Keokuk strata and overlying Pennsylvanian deposits (Branson 1944:399), whereas a more friable type appears to be associated with filled sinkholes developed in the Jefferson City–Cotter formation (Keller 1973:57). Most limonite deposits are probably found in the former location. Prehistorically, iron ore could have been collected from concentrated, localized residual sources on ridge slopes or from redeposited contexts among the local stream gravels.

SOILS

A soil report has not been prepared for Cedar County since Watson and Williams (1909). However, staff of the Natural Resources Conservation Service (NRCS) were undertaking field studies in the vicinity of the Big Eddy site during the archaeological investigations. In addition to visits by the field crew, Tom DeWitt, Soil Scientist with the NRCS, coordinated a two-day visit to the site with Edwin Hajic, one of the project's two geomorphologists. The NRCS provided preliminary field maps and, at the prompting of Tom DeWitt, the Missouri Soil Characterization Laboratory undertook detailed sediment and chemical analysis on a core from the Big Eddy site.

The surface soil at the Big Eddy site is classified as Cotter silt loam, a fine-silty, mixed, mesic Typic Arguidoll. The Cotter series developed in alluvium on nearly level high floodplains and old natural levees along streams. This soil is well drained and moderately permeable, and its horizons have pH values ranging from strongly acidic to neutral. The Cotter soil also correlates with the upper deposits of the Rodgers Shelter member, i.e., the middle and late Rodgers submembers (see Chapter 7).

Other soil series mapped in the immediate area of the Big Eddy site are: (1) Sturkie silt loam, a well-drained soil formed in alluvium and typical of levees and the more flood-prone portions of the floodplains; and (2) Moniteau silt loam, an alluvial soil similar to Sturkie in many respects except that it is poorly drained. In the immediate vicinity of the site, Sturkie silt loam is defined for a narrow strip (coincidental with the Pippins Cemetery member, see Chapter 7) lying between the site and the river to the west, as well as across the river to the south. Moniteau is mapped as an extensive area at the base of the bluffs about 0.5 km to the east and northeast of the site.

LATE PLEISTOCENE–HOLOCENE PALEOECOLOGY

Paleoecological studies have indicated numerous and sometimes dramatic changes in climatic, biotic, and (after ca. 11,500 B.P.) cultural patterns during the past 20,000 years in midcontinental North America (e.g., Baerreis et al. 1976; Bryson et al. 1970). Climatic changes would have had considerable direct and indirect impacts on settlement-subsistence strategies during at least terminal Pleistocene and Holocene times since they would have affected the density and types of plant cover and animal resources, hill-slope erosion rates, the extent and duration of flooding, and alluvial degradation or aggradation. The relative abundance and types of available fauna also would have changed in con-

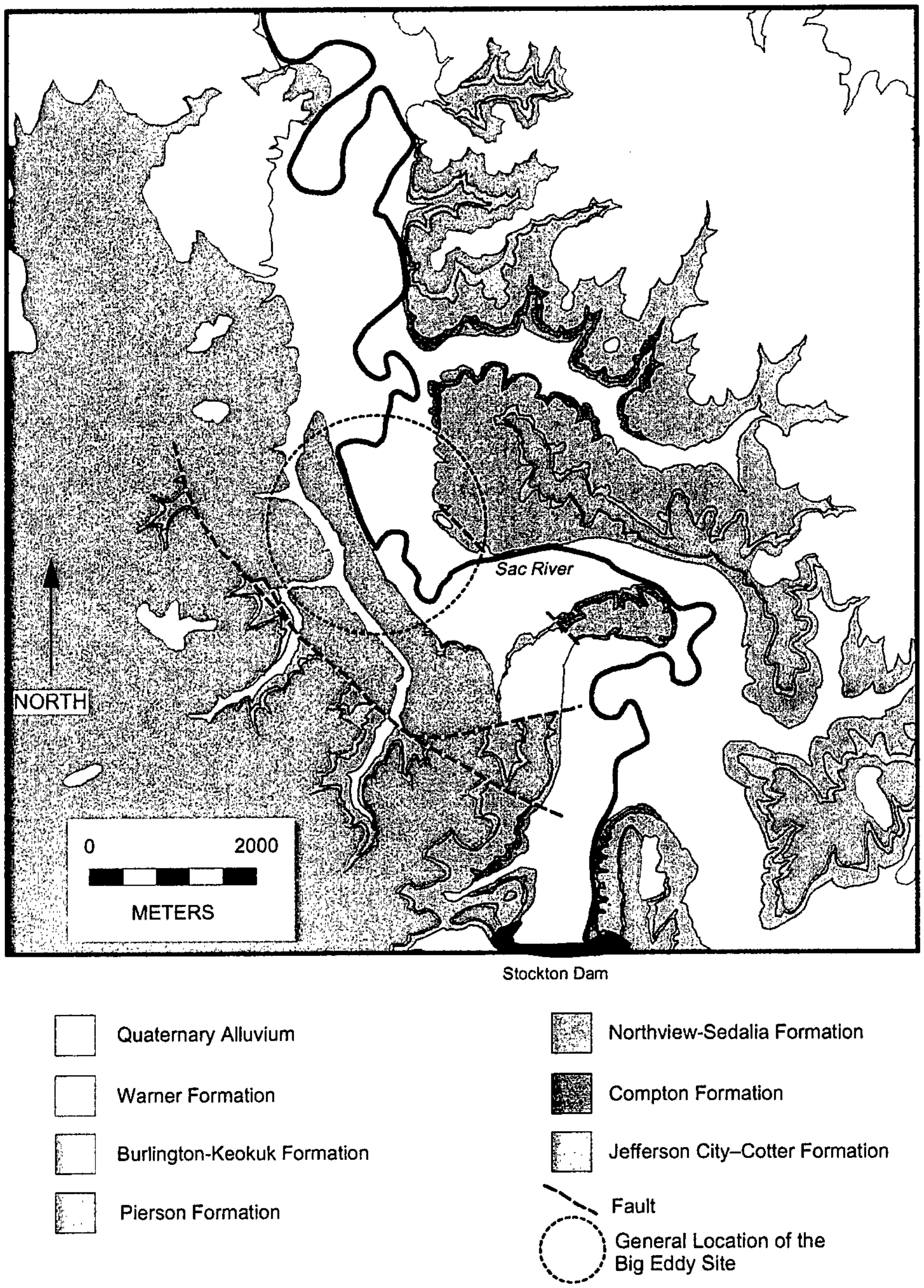


Figure 2.2. Geologic formations that outcrop in the project area (adapted from Neill 1987).

cert with increases or decreases in plant foods, cover, and water.

King (1973, 1988; King and Lindsay 1976) has presented palynological data from Trolinger, Boney, Koch, Phillips, and Kirby springs in the lower Pomme de Terre River valley. The pollen and macrofossil data from the first three sites provide a good vegetation and climatic record for the last half of the Pleistocene (i.e., for ca. 34,000–13,500 B.P.). Unfortunately, pollen and macrofossil data were not available for the terminal Pleistocene and much of the subsequent Holocene (i.e., from ca. 13,500 B.P. to ca. 4000 B.P.). The late Holocene record is represented at Boney Spring (profile VI), as well as at Koch and Phillips springs, but terminal Pleistocene through middle Holocene (ca. 13,500–4000 B,P.) pollen-bearing deposits are lacking. Their absence is attributed to hydrologic changes resulting in the cessation of spring discharge, along with down-cutting of some of the higher Pleistocene terraces as a result of increasing dryness and warmth during this period (King 1988). The major hiatus in the pollen record has resulted in greater reliance on archaeological data from Rodgers Shelter and in extrapolations from records established for other regions.

The last glacial maximum occurred about 20,000–18,000 B.P. (Frison and Walker 1990). At that time, the massive Laurentide ice sheet covered portions of northern Iowa, northern and central Illinois, all of Michigan, about two-thirds of Indiana, most of Ohio, northern Pennsylvania, and nearly all of New England to Long Island. From about ca. 16,000 B.P. on, the late Pleistocene was characterized by a gradual, but fluctuating, ice retreat. In general, the glacier was bordered by a band of tundra, which in turn was bordered by spruce-dominated boreal parkland and forests. As the glaciers moved northward, tundra, boreal, and deciduous species likewise moved northward in a time-transgressive manner.

The vegetation of southwest Missouri at about 18,000 B.P. apparently consisted of spruce-dominated parkland and forests with some oak and other deciduous elements as minor elements (King 1973). Trolinger and Boney springs contained deposits dating to the tail end of the Pomme de Terre sequence, showing that spruce-dominated forests existed in the region until at least 13,500 B.P. Faunal remains found within these deposits included elements of mastodon, tapir, ground sloth, deer, giant beaver, and horse, as well as a wide variety of smaller animals (King and Lindsay 1976:76; Saunders 1988:Tables 1–3). Based on the record from Boney Spring, King (1988:156) suggests that "by 13,500 B.P., spruce had begun to decline and cool temperate hardwoods began to increase in western Missouri."

The Pleistocene-Holocene boundary is often shown as a rather abrupt change in most pollen diagrams (Broecker et al. 1960; Davis 1976), although the termination of the Pleistocene varied from area to area. The establishment of deciduous and deciduous-coniferous (principally oak-pine) forests in the Midwest was largely completed sometime between ca. 12,000 and 10,000 B.P., depending in part on elevation and latitude. Although many extant species were present in the area by the end of this transitional period, the communities or associations formed by these plants (and animals) was different from those prevailing today (Dincauze 1993a). This was (and continues to be) due to a variety of factors, including the differential migration rates of various species and ongoing adaptive changes in individual species (e.g., Davis 1983; Webb et al. 1993).

The so-called Younger Dryas represented a final but short-lived return to cooler (and in some places dryer) conditions that favored the re-expansion of spruce in many places (e.g., Broecker et al. 1988; Dansgaard et al. 1989; Shane 1994). The Younger Dryas event was first defined in Europe, but much data have been accumulating to show that this event may have been global (e.g., Haynes 1991; Wilkins et al. 1991). Its North American signatures may be strongest in the maritime Canadian provinces and southern New England (Jouzel et al. 1992; Peteet 1992). The dating of this event is generally considered to be during the millennium of 11,000–10,000 B.P., perhaps lasting 300–400 years at most (Peteet 1992:336–341). More precisely, Haynes (1993:232–233) suggested that the cooler and dryer conditions characterizing the Younger Dryas date to ca. 11,000–10,750 B.P.

The Holocene is divided into three periods—early, middle and late. The early Holocene (ca. 11,000 to 9000/8000 B.P.) represents a continuation of the general warming trend established toward the end of the late Pleistocene. The early Holocene was cooler and wetter than at present, but certainly warmer than the late Pleistocene (King 1977; King and Allen 1977:321; Webb et al. 1993). Sea level rose rapidly during this period as glacial wastage occurred. As Webb et al. (1993) have demonstrated,

the period of 12,000–9000 B.P. witnessed the greatest climatic changes of the past 20,000 years. The Laurentide ice sheet, although diminishing at a rapid rate, still occupied vast portions of eastern and north-central Canada during the early Holocene. Its presence resulted in the dominance of cool and dry Canadian air masses (Knox 1983; Webb et al. 1993), gradually changing toward dominant Pacific air masses near the end of the early Holocene as the Laurentide ice sheet disintegrated. Sections of pollen profiles from many midwestern sites that date to the interval of 11,000–9000 B.P. show high percentages of herb or nonarboreal pollen, indicative of the expansion of prairie (Bernabo and Webb 1977; Davis 1965; McAndrews 1966, 1967; Wilkins et al. 1991; Wright 1976). Thus, this period witnessed the emergence of the so-called Prairie Peninsula (Transeau 1935), although it did not reach its maximum extent until the middle Holocene.

The middle Holocene (ca. 9000/8000 to 5000/4000 B.P.) is marked by the so-called Hypsithermal Interval (Deevey and Flint 1957; also referred to by some as the Altithermal [Antevs 1955] or the Xerothermic [Sears 1942]). It was a period of maximum dryness and perhaps temperature, representing the culmination of the trend that began at the end of the Pleistocene. Whereas the various names for this interval imply maximum temperatures, some research indicates that the decrease in effective moisture was more important than the rise in temperature in effecting biotic changes (e.g., Webb and Bryson 1972; King and Allen 1977). For example, Emiliani (1972) has suggested that global temperatures during the Hypsithermal peak were within only 1–2° C of modern temperatures.

The most prominent development during the Hypsithermal was the maximum expansion of prairie. The Prairie Peninsula reached its maximum extent around 7000 B.P. (Delcourt and Delcourt 1981, 1984; King 1977; Wright 1968), encroaching as far south as Kentucky and Tennessee, as far east as northwestern Pennsylvania, and as far north as central Wisconsin and Michigan. The long-term development of the Prairie Peninsula is considered to have coincided with a major shift in circulation patterning marked by "dry continental air from the west that lost its moisture over the western Cordillera" (Wright 1968:79). This resulted in droughts, greater evapotranspiration, and higher temperatures. Even today, the Prairie Peninsula, although diminished in extent, occupies an area dominated by dry westerly air for about 6–9 months during average years and 9–12 months during drought years (Borchert 1950; Knox 1983; Ruhe 1974).

Paleoecological conditions during the late Holocene (5000/4000 B.P. to the present) are essentially comparable to those prevailing today, although this period has been characterized by several perturbations of minor to moderate magnitude (e.g., Bryson and Wendland 1967; Denton and Karlén 1973; Swain 1978). In general, King (1977:14) has suggested that late Holocene climate has been "a climatic regime of its own, wetter than the dry period that preceded it but not as wet as the early Holocene." A cooling trend has been repeatedly documented in North America, represented partly by glacial expansion and the southward expansion of spruce in northern latitudes (Bernabo and Webb 1977; Gajewski 1988). The resumption of discharge at several springs in the lower Pomme de Terre River valley in the western Ozarks probably reflects a rebound in available moisture. The increased coolness and moisture has been attributed to the increased penetration of both dry polar and moist tropical air masses in the Midwest, resulting in relatively "slow-moving storm systems [that] generate persistent heavy rains followed by large floods" (Knox 1983:31).

During the late Holocene, there apparently has been slow forest encroachment into prairie (King 1977; Ruhe 1974). Although some changes in the composition and structure of vegetational communities may have occurred in the last 5,000 to 4,000 years, many authorities would contend that at least arboreal vegetation patterns remained essentially stable prior to Euroamerican settlement and massive land clearance (McAndrews 1966, 1967; Brubaker 1975; King 1977; King and Allen 1977; Wright et al. 1963; Zant 1979). The major climatic episode during the late Holocene was apparently the Neo-Boreal or Little Ice Age, which dates to about 500–150 B.P. (Denton and Karlén 1973; Wendland and Bryson 1974).

LATE HOLOCENE PRESETTLEMENT VEGETATION PATTERNS

The lower Sac River valley and the Big Eddy site are situated along the edge of the oak-hickory forest of the Ozarks and the tall grass prairie of the Plains (Figure 2.3). Modern land use in the lower Sac River valley includes crop fields, cultivated hay fields, and pasture. Light forest exists mainly along field edges, stream borders, and on the steeper

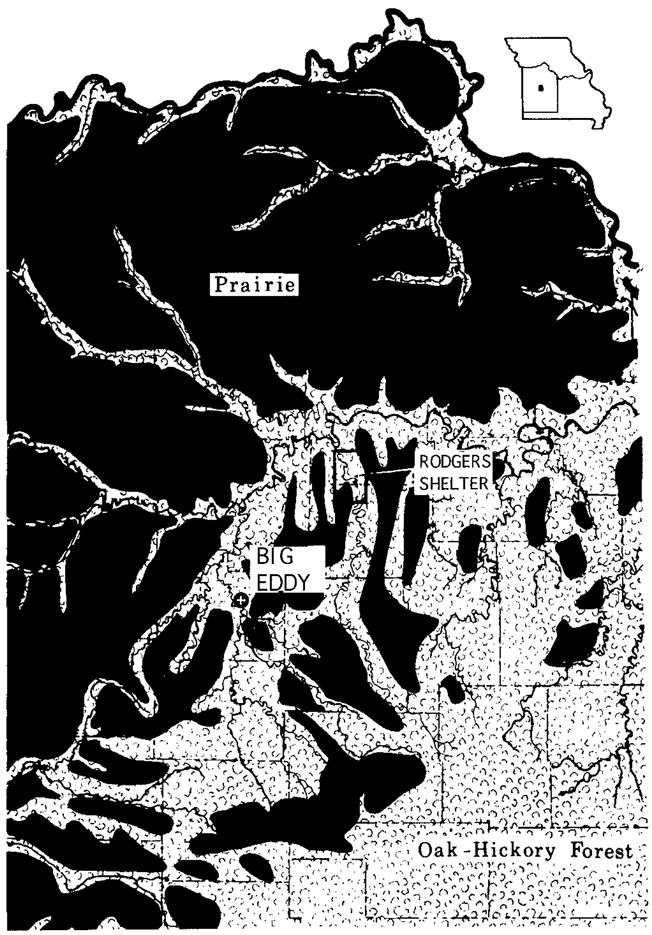


Figure 2.3. Location of Big Eddy in relation to forest and prairie areas (adapted from McMillan 1976b:Figure 2.3).

slopes. Before intense settlement by Euroamericans, the stream bottoms and uplands in the area were composed of a mosaic of woodlands and prairies. The natural vegetation of the Ozark Highland is oak-hickory forest with native prairie grasses covering flat uplands in places. Nonetheless, considerable local variation exists throughout the Ozark Highland with regard to dominant overstory species (e.g., Steyermark 1959). This variation is caused by differences in such factors as direction of slope, soils, elevation, and bedrock, but the basic differences among drainage basins are ones of degree, not kind. Logging and plow agriculture have left little of the original presettlement vegetation intact. Formerly, the location of the Big Eddy site on the Sac River allowed access to prairie, open woodland, floodplain forest, and aquatic habitats.

In order to reconstruct the fabric of presettlement vegetation in the absence of local pollen data, it has become commonplace to rely on early nineteenth-century General Land Office (GLO) survey data. Nonetheless, it is also important to use caution in applying vegetational models based on historic data to prehistoric times, since climatic conditions have changed during the Holocene (see above). At best, such models are most applicable to late Holocene times, when essentially modern climatic conditions prevailed. They most certainly do not apply to late Pleistocene conditions and only in a general way to the early and middle Holocene. It is also important to recognize that climatic changes during the last 5,000 years could have affected the composition and distribution of vegetational communities. For example, Wood (1976) has warned

that most GLO surveys were undertaken during the tail end of the Neo-Boreal or Little Ice Age (ca. A.D. 1500–1850), which was characterized by colder and moister conditions than at present and prior to the sixteenth century.

Using early nineteenth-century GLO survey data, McMillan (1976b:20–35) and King (1982b:12–19) modeled plant communities for the nearby lower Pomme de Terre River valley. The vegetation consisted of a mosaic of forests, woodlands, barrens, and prairies. Major floodplains would have been dominated by bottomland forest and woodlands; oak, hickory, and maple would have been the most common trees, but species diversity and stem density would have been high. Prairies and barrens dominated the uplands. King (1982b:18–21) notes that regional soils derived from Mississippian limestone bedrock usually supported open oak barrens in which tree-stem density was low; similar environments in Benton County supported 15–20 trees per acre (King 1982b:17). Trees usually consisted of post, black, blackjack, and pin oaks. Fine-grained soils derived from Pennsylvanian shale usually supported prairie grasses. Typical species included sedges and marsh grasses in the poorly drained lowlands and big bluestem and Indian grass in the better-drained uplands.

For the lower Sac River valley, GLO survey field notes and plat maps have been intensively studied for three townships: T34–36N, R26W. Owing to the irregularity of sections in T34N R26W, the sample covers an area of slightly more than 280 km^2. The Big Eddy site is situated in the southern portion of this study area. The north-south transect of townships was selected because it included the Sac River floodplain, thereby increasing the sample of bottomland trees and line descriptions. Some township lines were surveyed in 1821, 1833, and 1835, whereas section lines within the three townships were initially surveyed during the winters and springs of 1834–1837. By the 1830s, some Euroamericans had settled in the area, but no houses, no roads, and relatively few fields or "improvements" were identified by the surveyors for the three studied townships. (For purposes of understanding recorded distances in GLO records, note that: 1 link [lk] = 0.66 feet; one chain [ch] = 66 feet; and 80 chains = 1 mile.)

Before describing the GLO data, some basic terminology must be clarified. The term *woodland(s)* is used here to connote the open-canopied nature of timbered lands in both upland and bottomland contexts. Woodlands may be thought of as being intermediate between the forests and the so-called "barrens" or savanna-like vegetation. Engelmann (1863:893) characterized the barrens of southern Illinois as "hills covered with a dense growth of tall grasses, without or with only scattering large trees." The term *forest(s)* is used to describe closed-canopied timber stands. For the purpose of distinguishing barrens, woodlands, and forests, we shall use the following (e.g., see Anderson and Anderson 1975; Brown 1950; Curtis 1959):

Barrens	1–19 trees/ha
Woodlands	20–39 trees/ha
Forests	40 or more trees/ha

General assumptions and calculations of distances between trees are based on the random pairs method (Cottom and Curtis 1949) for quarter-section corners and on the quarter method (Cottom and Curtis 1956) for section corners where four witness trees were described.

The plat map for T34N R26W, wherein the Big Eddy site is located, is shown in Figure 2.4. Although not apparent in this figure due to inclusion of barrens with "timbered" land, the GLO records indicate roughly equal amounts of prairie, barrens, and timbered lands in this portion of the Sac River valley. For T34N R26W, the numbers of quarter-section and section corners at which upland prairie, barrens, and upland woodlands were identified (excluding those in "improvements" or fields) were roughly equal: 25, 27, and 21, respectively.

The uplands were described by the GLO surveyors as ranging from flat to hilly, but mostly gently rolling with gravelly, stony, and/or sandy soils. Only some minor differences between the types of oaks found in the barrens vs. the timbered areas are apparent in the data. Among these differences, white oaks, particularly larger ones, occurred more frequently in the small upland stream valleys and along the dissected bluffs of the Sac River (i.e., in more mesic situations). In contrast, blackjack oaks were mostly present in areas identified as barrens or having "scattering timber." Post oaks, black oaks, and hickories were scattered equally in both the barrens and the upland woodlands. At some quarter-section and section corners, only a single tree was found, identified, measured, and blazed, with the surveyor's comment, "no other tree within a convenient distance."

Based on a sample of 25 quarter-section and section corners in the uplands where two or more trees were identified and measured, the mean den-

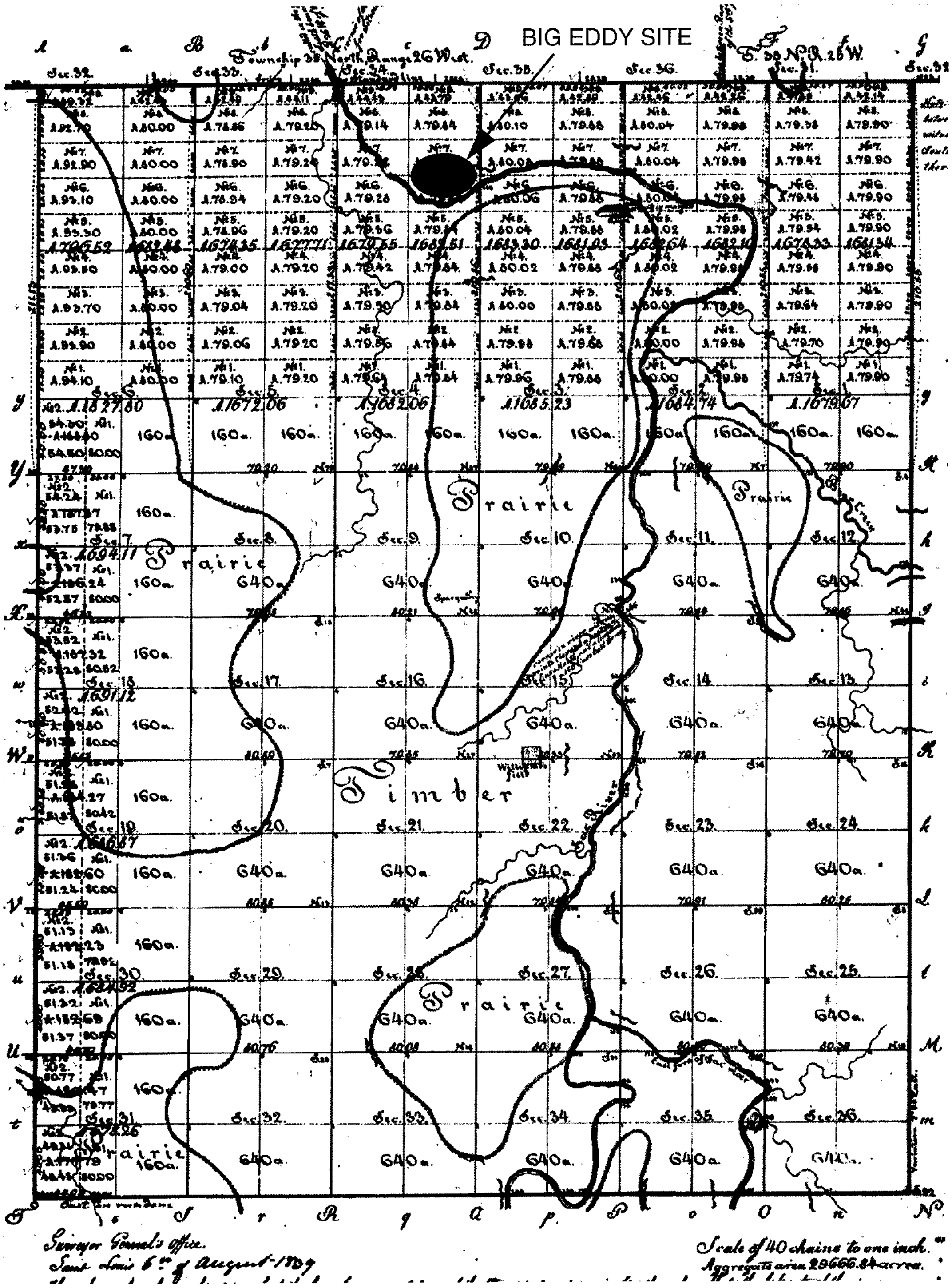


Figure 2.4. Government Land Office plat map for T34N R26W depicting prairie and forest distribution.

sity of trees is 28.9 trees/ha, with a range of 4.9–327.8 trees/ha. Excluding the singular aberrantly high density of 327.8 trees/ha, the mean drops to 16.5 trees/ha, with a range of 4.9–59.1 trees/ha. Although sample sizes are small (n=13 and 11), the respective mean tree densities for corners identified as being in barrens vs. those identified as not being in barrens are 14.4 trees/ha and 18.9 trees/ha. Based on the different tree-density ranges for barrens, woodlands, and forests, 17 corners were in barrens, six were in woodlands, and two were in closed-canopied forests.

Witness- and line-tree data are presented in Table 2.1, and line-description data are presented in Table 2.2. Oaks and hickories were the only trees recorded at quarter-section and section corners in the uplands. Post oak was the most common, followed by black oak, hickory, blackjack oak, and white oak. The basal-area estimates, however, show white oaks as contributing substantially more wood mass than either hickory or blackjack oak (Table 2.1). Given the infrequency with which white oaks were mentioned in the line descriptions, however, it may have been a considerably more uncommon tree in the uplands than implied by the witness- and line-tree data. It is conceivable that the surveyors were biased in favor of locating white oaks because of their relatively great durability, lifespan, and size.

The most frequently mentioned trees in the line descriptions were also oaks and hickories (Table 2.2). Some examples of line descriptions pertaining to the uplands in the vicinity of the Big Eddy site to the west are as follows:

> [North between irregular Sections 4 and 5, T34N, R26W at 120–160 chains] Land rolling and gravelly - 2nd rate barrens - fit for cultivation - Timber scattering Black oak and Hickory - undergrowth of the same with Hazle [sic] and Redroot.
>
> [North between irregular Sections 5 and 6, T34N, R26W at 120–160 chains] Land rolling and gravelly - soil 2nd rate - part fit for cultivation - Timber Hickory, Black Jack and Post oak - no undergrowth.

Some descriptions for other upland locations in the sampled townships are as follows:

> [North along West boundary of Section 30, T35N, R26W at 40–80 chains] Land South end - gently rolling prairie - second rate - Soil fit for cultivation - North end of the 1/2 mile - Rolling and stony - poor soil not fit for cultivation - Timber post oak and Black Jack.
>
> [North between Sections 11 and 12, T36N, R26W at 0–40 chains] Land good - second rate - rolling and sandy - Thinly timbered with Oak and Hickory - undergrowth Sumac and hazel, vines etc.

Of the oaks identified in the line descriptions, post oak was mentioned most frequently, followed by blackjack oak and black oak. Other than these three oaks and hickory, all other trees (except perhaps for white oak) would appear to have been very minor timber elements of the barrens and upland woodlands. Minor constituents of the upland woodlands mentioned in line descriptions consisted of red oak (*Quercus rubra* or *Q. Shumardii*), elm, cherry (probably *Prunus serotina*), and sassafras (*Sassafras albidum*). The understory vegetation appears to have been somewhat more diverse, although hazelnut (*Corylus americana*) was by far the most frequently mentioned constituent besides saplings of the overstory trees (as noted by the comment, "undergrowth the same," which invariably followed the list of dominant timber). Vines and hickory saplings follow in frequency of mention; the term vines is presumably generic, although it probably does refer to wild grapes (*Vitis* spp. or *Ampelopsis cordata*) more so than anything else. Other undergrowth that could have been of potential economic importance included sumac (*Rhus* sp.), "Plumb" or plum (*Prunus* spp.), and "Redroot" or New Jersey tea (*Ceanothus americanus* or *C. ovatus*).

The bottomland of the Sac also had relatively extensive areas of floodplain prairie. Bottomland prairie and bottomland woodlands and forests were each identified at 14 quarter-section and section corners. Based on a sample of 25 quarter-section and section corners in the bottomlands, the mean density of trees is 36.4 trees/ha, with a range of 0.7–149.1 trees/ha. The mean is nearly double that of the upland sample. Based on the different tree-density ranges for barrens, woodlands, and forests, 13 corners were in barrens/savannas, five were in woodlands, and seven were in closed-canopied forests. A far greater percentage of corners

Table 2.1. Witness and Line Trees Mentioned in GLO Field Notes for T34-36N, R26W.

		Bottomland					Upland				
Tree Mentioned	Taxonomic Equivalent	N	%	Diameter Range (cm)	Mean Diameter (cm)	Basal Area[a] (m^2)	N	%	Diameter Range (cm)	Mean Diameter (cm)	Basal Area[a] (m^2)
Post oak	*Quercus stellata*						149	30.5	10.2–91.4	38.1	19.0594
Blackjack oak	*Quercus marilandica*						72	14.6	10.2–61.0	26.4	4.3030
Black oak	*Quercus velutina*	1	0.8	35.6	35.6	0.0993	120	24.6	12.7–101.6	38.4	15.9275
Spanish oak	*Quercus velutina* (?)	20	16.4	12.7–91.4	47.2	4.4245	2	0.4	15.2, 25.4	20.3	0.0688
White oak	*Quercus alba*	4	3.3	35.6–61.0	48.3	0.7577	64	13.1	15.2 101.6	42.5	11.4173
Burr oak	*Quercus macrocarpa*	12	9.8	30.5–127.0	66.5	5.1142					
Pin oak	*Quercus palustris*	2	1.6	35.6, 40.6	38.1	0.2290	1	0.2	35.6	35.6	0.0993
Water oak	*Quercus imbricaria* (?)	16	13.1	15.2–76.2	38.3	2.4208					
Hickory	*Carya* spp.	20	16.4	15.2–71.1	29.0	2.0891	80	16.4	15.2–50.8	25.9	4.8373
Pecan	*Carya illinoensis*	1	0.8	38.1	38.1	0.1140					
Walnut	*Juglans* spp.	4	3.3	38.1–76.2	48.3	0.8134					
Black walnut	*Juglans nigra*	5	4.1	30.1–101.6	48.8	1.2317					
Elm	*Ulmus* spp.	20	16.4	15.2–91.4	37.4	2.8092					
Maple	*Acer* spp.	2	1.6	20.3, 22.9	21.6	0.0734					
Sugar maple	*Acer saccharum*	1	0.8	35.6	35.6	0.0993					
Box elder	*Acer negundo*	3	2.5	25.4–30.5	28.8	0.1965					
Ash	*Fraxinus* spp.	1	0.8	15.2	15.2	0.0182					
Lynn	*Tilia americana*	1	0.8	50.8	50.8	0.2026					
Mulberry	*Morus rubra*	1	0.8	30.5	30.5	0.0729					
Hackberry	*Celtis* spp.	2	1.6	30.5, 76.2	53.3	0.5287					
Birch	*Betula nigra*	2	1.6	12.7, 25.4	19.0	0.0633					
Sycamore	*Platanus occidentalis*	2	1.6	50.8, 254.0	152.4	5.2671					
Willow	*Salix* spp.	2	1.6	15.2, 20.3	17.8	0.0506					
Total		122	99.7	12.7–254.0	42.0	26.6755	488	99.8	10.2–101.6	34.9	55.7126

[a] Basal area (m^2) =.00007854(dbh^2), where dbh = diameter at breast height in cm (Husch et al. 1972:100).

Table 2.2. Number of Times Species Mentioned in Line Descriptions for T34–36N, R26W.

Timber Type	Upland	Bottomland	Undergrowth Type	Upland	Bottomland
Oak	93	24	Hazle/hazel	25	16
Post oak	74		Hazel thicket	1	
Black oak	47		Briers	1	8
Blackjack oak	51		Green briers		1
White oak	8		Vines	11	17
Burr oak		13	Grapevines	1	
Water oak		5	Poison oak		1
Red oak	1		Spice/spice wood		21
Spanish oak		6	Grass		1
Pin oak		1	Redroot	2	
Swamp oak		1	Pawpaw		4
Scrubby oak	1		Sumac/sumach	3	
Hickory	138	26	Plumb	1	
Walnut	1	20	Pin oak	1	
Black walnut		3	Oak brush	1	1
White walnut		2	Groundoak	2	2
Elm	1	11	Hickory	10	1
Ash		10	Hickory grubs	1	
Hackberry		9	Red Bud	2	3
Sycamore		6	Dogwood		1
Maple		1	Swamp dogwood		3
Sugartree		1	Sassafras	1	1
Box elder		1	Box elder		1
Cherry	1		Brush		1
Mulberry		1	Undergrowth same	54	1
Sassafras	1		No undergrowth	6	1
Coffeebean		1			

occur in bottomland forests than upland forests, but the numbers still indicate that the bulk of the timbered floodplain was relatively open.

The floodplains supported a substantially more diverse set of resources than the uplands. In contrast to the seven taxa of witness and bearing trees represented in the upland sample of 488 trees, at least 21 taxa are represented in the bottomland sample of only 122 trees, or a sample of exactly one-fourth the size of that for the uplands. None exceed about 17% of the sample. Trees in the floodplain were also generally larger, as is evident by the mean diameters shown in Table 2.1.

The most common witness and line trees in the bottomland sample were "Spanish oak," hickory, and elm, followed by "water oak" and burr oak (Table 2.1). The exact equivalents for water oak and Spanish oak are impossible to ascertain, but it seems likely that they referred to shingle oak and black oak or a hybrid thereof. At least two different deputy surveyors (Joseph Montgomery and Jesse Applegate, who supervised the section line surveys in T34N R26W and T36N R26W, respectively) used the terms water oak and pin oak. This fact precludes the contention that water oak was another term for pin oak, although pin oak is sometimes referred to as water oak (Steyermark 1963:550). It is argued here that water oak actually refers to shingle oak. Water oak is used today to refer to two species (*Quercus phellos* and *Q. nigra*), both of which are not presently distributed in the area, since they are adapted to the warmer and wetter conditions of the Southeast (e.g., see Fowells 1965:628; Steyermark 1963:542–543). *Q. phellos* and shingle oak are the only two oaks in the Midwest that have unlobed, untoothed leaves. The barks of the two trees also

are somewhat similar, and shingle oak is a common tree in the lower Sac Valley today. Thus, it is assumed here that references to water oak and swamp oak likely refer to shingle oak. At least Jesse Applegate also used the terms Spanish oak and black oak, but the southern red or Spanish oak (*Q. falcata*) does not range into this area. Since the surveys were undertaken in the winter and early spring, it can be assumed that the identifications were based principally on tree form and bark. Black oak and southern red oak have similar tree forms and shallowly furrowed bark. Furthermore, black oaks are quite variable and hybridize readily with other species (Steyermark 1963:545). Thus, it is assumed here that the term Spanish oak probably refers to the black oak or a local hybrid thereof.

The trees and undergrowth mentioned in line descriptions likewise are indicative of considerably more diversity than was present in the uplands. Some examples of line descriptions illustrating the diversity of flora formerly evident in the Sac River floodplain near the Big Eddy site are as follows:

> [North between irregular Sections 1 and 2, T34N, R26W at 40–80 chains] Land 2nd rate bottom - fit for cultivation - Timber Burr oak, Hickory, Walnut and Water oak - undergrowth Spice wood and Hazle.
>
> [North between irregular Sections 3 and 4, T34N, R26W at 120–160 chains] Land rich bottom - partially liable to inundation - Timber Burr oak, Hickory and Spanish oak - undergrowth Spice wood, Hazle and grapevines.

For floodplains of tributary valleys, in this case a portion of the Turkey Creek valley east-northeast of the Big Eddy site, the following description was recorded:

> [North along East boundary of Section 12, T35N, R26W at 40–80 chains] Land - South end second rate - Soil fit for cultivation - Timber post oak and Black oak - Middle and Bottom part rich - Soil fit for cultivation - Timber Walnut, Mulberry and Oak - undergrowth hazle, Briers and vines - North end a stony hill - poor Soil - not fit for cultivation - Timber post oak.

The line descriptions for the bottomland indicate more evenness in the distribution of dominant overstory trees and understory constituents than was the case for the uplands.

As expected, the GLO data indicate that the greatest density and diversity of plants, presumably including economically useful ones, occurred in the floodplain. They included a number of tree taxa that produce edible fruits, seeds, sap, and other products, species such as pecan, walnut, sugar maple, hackberry, and mulberry. Hickories comprised 16.4% of the trees in each of the bottomland and upland samples, but it should be emphasized that hickories were about twice as abundant in the bottomlands and they averaged about 20% more basal area per tree. The latter should reflect larger boles and, therefore, greater mast production in at least the bottomland barrens/savannas and woodlands. Given that almost one-fourth of the line descriptions pertain to bottomland situations, the abundance of understory vegetation, including economically useful plants, also must have been quite substantial in comparison to that occurring in the uplands. Based on the sample of line descriptions, hazelnut, spice bush (*Lindera benzoin*), and vines (presumably of wild grape and raccoon grape) must have been very common understory species in the bottomlands. Other edible and medicinal taxa mentioned exclusively for bottomland situations minimally included green brier (*Smilax* spp.) and pawpaw (*Asimina triloba*).

The GLO surveyors noted extensive prairies in the bottomlands and the uplands of the Sac River basin. Unfortunately, they provide essentially no description of the contents of the prairies and much reliance must be given to the relatively few early historic descriptions of such prairies. According to Schroeder (1981:12), the prairies of the western Ozarks were relatively "discrete landscape units on a rolling-to-level upland, bounded by wide belts of timbered hill country along the stream valleys entrenched in the Ozark limestones." Such prairies were dominated by big bluestem and little bluestem. Based on his observation of the prairies in Greene County during the winter of 1819, Henry Schoolcraft (from Park 1955:113) remarked that "[the prairies] are covered by a coarse wild grass, which attains so great a height that it completely hides a man on horseback in riding through it." Line descriptions for bottomland prairie almost invariably state "land level - first rate bottom - fit for cultivation." In several instances, the prairie areas also were described as being "wet," indicating that at least some of the bottomland prairies conformed to wet prairies, whereas others may have been dry prairies occupying higher, better-drained terraces.

FAUNAL RESOURCES

McMillan (1976b:35–41) provides a good discussion of the variety of historically available fauna in the nearby Pomme de Terre drainage. Use of modern fauna as a backdrop for understanding the prehistoric record, however, must also be undertaken cautiously. Models of past conditions based on modern fauna ignore the extensive effects of Euroamerican settlement, timber clearance, agricultural activities, dam construction, and other historic activities. In addition, fauna must respond to climatically induced changes in vegetation patterns and composition, hydrology, and so forth; such perturbations must have affected fauna-procurement patterns and species availability to some extent.

Paleoindians were present in North America when Ice Age megafauna still roamed the landscape. However, the Paleoindian period began at a time when many megafauna species were approaching extinction. The cause or causes for the relatively rapid extinction of at least 35 genera of late Pleistocene mammals throughout the world is unresolved (Martin and Klein 1984), but it is clear that most if not all of them became extinct at the end of the Pleistocene, with few if any surviving into the Holocene. Meltzer and Mead (1983) contended that large Pleistocene mammals in North America had reached the brink of extinction by 10,500 B.P. or so. Such a date, however, has been challenged by Grayson (1987:289), who concluded:

> many of the genera that have yet to be dated to terminal Wisconsin times may not have survived beyond 12,000 yr B.P., and...population numbers of many genera that did survive into the terminal Wisconsin may have significantly dwindled by then.

Others place the demise of many of the megafauna in North America around 11,000 B.P., attributing their extinction to climatic change combined with successful human exploitation (e.g., Haynes 1991).

A fully modern fauna became established in the Midwest during the Holocene. Even so, some changes in the abundance and distribution of fauna would be expected in light of the climatic and vegetational changes evident for the Holocene. The effects of these changes should be most marked in an area such as the lower Sac River valley, which occupies a sensitive position on the Plains–Eastern Woodlands border, a sort of "battleground" between the prairie and oak-hickory forests. As such, the effects of climatic change, such as that which occurred as a consequence of the Hypsithermal Interval, would have been most pronounced along this boundary (for possible effects in the nearby Pomme de Terre Valley, see McMillan [1976a]).

The faunal record from Rodgers Shelter indicates that white-tailed deer was the main source of food, although rabbits and squirrels also were important smaller mammalian resources. Elk and bison remains are present in the early Holocene record at Rodgers Shelter. Other taxa represented at the site included several species of mussels and fish, aquatic and terrestrial turtles, beaver, muskrat, raccoon, skunk, and turkey, among the most prominent.

Evidence for changes in habitat patterns and procurement strategies related to the Hypsithermal Interval is abundant. Even so, the effects were perhaps not as pronounced as some contend. Purdue (1982) observed a number of changes pointing to the effects of the Hypsithermal Interval, but also notes several aspects of his systematically collected faunal assemblage that do not support large-scale changes in plant and animal distribution. Of those that do, for example, he notes that remains of mostly slackwater gar, suckers, and catfish peak in the middle Holocene deposits, whereas remains of sunfish peak in the late Holocene deposits. This may represent a change from greater pooling of water during a period of lower precipitation to one of increased stream flow because of increased precipitation. Purdue (1982) also documents changes in body sizes of rabbits and squirrels, with the largest sizes for both species represented in the early Holocene when conditions were most moist. In turn, the smallest sizes for these two animals are found in the dryer middle Holocene deposits, with an increase in body sizes (but not as great as the body sizes for the early Holocene) during the late Holocene when precipitation rebounded somewhat. Various aspects of the mussel and gastropod populations also provide some support for McMillan's (1976a) contention about the effects of the Hypsithermal (see Baerreis and Theler 1982; Klippel et al. 1982).

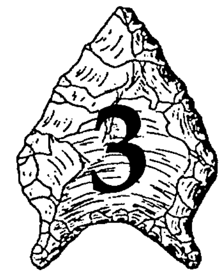
The late Holocene encompasses a time when human population densities increased, territories diminished in size, resource-exploitation patterns diversified, sedentism became commonplace, and plant cultivation became increasingly important. The river valleys became important places for late Holocene populations to aggregate since they of-

fered rich, fertile soil; water; immediate access to transportation routes; and the greatest density and diversity of plant and animal resources. Locations such as that occupied by the Big Eddy site provided easy access to the full range of available habitats.

The Sac River itself would have been a dependable source for mussels, fish, turtles, aquatic waterfowl, beaver, and muskrat. The low gradient and width of the Sac River valley is conducive to the formation of meander cut-offs, seasonal lakes and ponds, and other types of wetlands, more so than other Ozark streams. The scattered occurrences of oxbow lakes and meander scars and the frequent mention of "rich bottom liable to inundation" by the land surveyors in the 1830s indicate the former presence of relatively abundant wetland biotic communities. Faunal evidence from Rodgers Shelter demonstrates that mussels became increasingly important during late Holocene times, possibly due to increasing regional population size and increased resource demands (Klippel et al. 1982:172–173).

The timbered uplands and bottomlands would have provided habitats and food for a wide array of terrestrial animals. Chief among these were deer, turkey, and squirrel, as well as perhaps rabbit and raccoon. The abundance of oaks in the area would have supplied a large amount of mast for deer, turkey, and squirrels in the fall and early winter. The prairies of historic and prehistoric times also must have been commonly exploited for a variety of resources. In describing the prairies in the vicinity of present-day Springfield, Missouri, Schoolcraft (Park 1955:113) remarked that "the deer and elk abound in this quarter, and the buffaloe is occasionally seen in droves upon the prairie, and in the open high-land woods." In another early historic description of resident fauna in the prairie lands of Bates County (northwest of Cedar County), Victor Tixier (McDermott 1940; cited in Schroeder 1981:12) stated, "on the plains [the prairies] we encountered small troops of five or six deer, prairie hens, woodcocks." In the nearby timbered lands, ducks, rabbits, raccoons, foxes, and deer were noted to abound (Schroeder 1981:12).

REGIONAL CULTURAL HISTORY



Neal H. Lopinot

Chapman's (1975, 1980) two-volume set provides a basic overview of the prehistory of Missouri. A more recent publication by O'Brien and Wood (1998) provides somewhat of an update to Chapman's work, but O'Brien and Wood focus less on what, when, and where questions and more on explanations of the hows and whys of cultural variability. This recent publication and a scan of the published literature illustrate that only a very meager amount of published data has accumulated for this region since 1980. A considerable number of projects have been undertaken since that time, but much of the new data remain largely hidden in the gray literature of cultural resources management. Still, our knowledge of the archaeology of the Sac River valley remains limited, largely due to a lack of extensive excavations and dating of diagnostic artifacts (e.g., the grit-tempered and sand-tempered ceramics from 23CE442 and 23SR1067 or the buried deposits at sites discussed in Chapter 1). Even in the absence of diagnostic artifacts, information on site burial could add considerably to our understanding of site formation and our general understanding of prehistory in the Sac River valley.

Until the Big Eddy project was implemented, only five other prehistoric sites in the middle and lower Sac River valley proper had been extensively excavated (see Perttula and Purrington 1988:Table 3). They are 23DA223, 23DA231, 23CE120, 23CE153, and 23PO309. Structures and pits were delineated at three of these sites: 23CE120 (the Dryocopus site), 23CE153 (the Flycatcher site), and 23PO309 (the Shady Grove site) (Calabrese et al. 1968, 1969; Pangborn 1967; Ward 1968). The bulk of earlier pre-impoundment investigations for the proposed Stockton Lake focused on sheltered sites, burial mounds, and bluff-top sites. Although the excavation of burial mounds prior to looting resulted in the salvage of much important information and human remains, the rich resources of the floodplain went largely unexplored in the Stockton impoundment area.

The absence of more information about local chronological markers, much of which can only be gained by large-scale excavations, requires considerable reliance on records and temporal frameworks established elsewhere. Still, our knowledge about particular periods (e.g., Early Woodland), specific point styles (e.g., Big Sandy or Afton), food-procurement strategies, forms of settlement, and many others aspects of human adaptation for vast portions of the Ozark Highlands and adjoining prairie regions is poor at best. Thus, it is essential to apply broader panregional chronological divisions and adaptational scenarios very loosely to the lower Sac River drainage.

The basic prehistoric sequence is described in this chapter. Given the nature of the deposits represented at the Big Eddy site, however, considerable attention is paid to the Paleoindian period and pre-Clovis times. This is not meant to diminish the importance of other periods, since the later deposits at the Big Eddy site also merit important consideration. Rather, the extended discussions of pre-Clovis and Paleoindian are given to provide a better context for understanding these unique deposits at the Big Eddy site. The breadth of the discussion also extends well beyond the region, since any in situ Paleoindian and pre-Clovis deposits have national, if not international, significance.

PRE-CLOVIS (CA. 40,000–11,600 B.P.)

The search for and debate over the existence of pre-Clovis in the New World has raged sporadically for well over a century (Meltzer 1983, 1991). Two primary episodes of debate can be defined, one dating to 1890–1927 and the other roughly dating to 1960–1997. During these two periods, proponents for pre-Clovis peoples in the New World (e.g., Abbott 1876, 1889, 1892; Irving 1985; Krieger 1964; MacNeish 1976, 1979; Wright 1889) have been matched by an equal number of critics (e.g., Dincauze 1984; Haynes 1969, 1982, 1988; Holmes 1890, 1893, 1918, 1919; Hrdlička 1907; Martin 1967, 1973). Critics have consistently raised questions regarding the quality of field methods, the competence of the excavators, the nature of stratigraphic contexts, the validity of relative or absolute dates, possibilities of geochemical and biological contamination by earlier or later materials, the absence of temporally diagnostic formal tools, and the occurrence of artifacts vs. geofacts. Although such critics have been accused of being blinded by a "Nothing-Before-Clovis" paradigm and of demanding excessively rigorous scrutiny for anything thought to be Paleolithic, pre-Projectile Point, or pre-Clovis (e.g., Alsoszatai-Petheo 1986; Bryan 1986), they have correctly emphasized the need for caution as well as careful documentation and evaluation of contextual data. The need for painstaking documentation and for a conservative approach to interpretation has been validated by the fact that many purported finds of pre-Clovis assemblages have been laid to rest by more recent ^{14}C assays, reassessments of geomorphic contexts, and studies of site-formation and taphonomic processes.

Dillehay's (1989, 1997) recent completion of the exhaustive two-volume report on the Monte Verde site in south-central Chile has done much to dispel skepticism about the existence of pre-Clovis people in the New World (Meltzer et al. 1997). The site was apparently occupied ca. 12,500 B.P., and the evidence marshalled to support human settlement has been derived from a vast array of stratigraphical, chronological, botanical, zoological, and lithic studies. A possible earlier component also was defined at this site. It is dated ca. 32,000–34,000 B.P., which is bracketed stratigraphically by dates of about 23,000–28,000 B. P. and >42,100 B.P. (Dillehay and Pino 1997).

Despite widespread acceptance of the validity of the Monte Verde site as pre-Clovis, nearly all of the same basic questions about the peopling of the Americas still remain at the forefront of research. Who were they? When did they arrive? How did they arrive and from where? It should also be noted that the presence of pre-Clovis populations in South America does not give cause for rejection of colonizing Early Paleoindian models, at least for North America (Anderson 1990b, 1995a; Beaton 1991; Kelly and Todd 1988; Tankersley 1994), nor for rejection of the related argument that megafauna extinctions were caused in part by overkill from the new wave of well-equipped, highly skilled Paleoindian hunters (Agenbroad 1988; Haynes 1966, 1982; Martin 1967, 1984).

More recent geological evidence, linguistic studies, amino acid racemization, and archaeological excavations also seem to support the likelihood that people were present in the New World, including North America, during pre-Clovis times as early as 40,000–35,000 B.P. or more. In Missouri and elsewhere in the Midwest, however, the evidence is scant and impeachable. For example, evidence for a pre-Clovis occupation of the Shriver site can be debunked (e.g., see O'Brien and Wood 1998:38–39) and considerable question should be raised about any human modification or use of the purported artifacts found associated with mammoth remains along the Missouri River in Saline County, Missouri (Hamilton 1993; see O'Brien and Wood 1998:Figure 2.16).

In fact, flawless evidence for the presence of pre-Clovis people in North America is still lacking, although several sites and new data have provided tantalizing but still controversial evidence for their existence (e.g., Adovasio et al. 1978, 1982; Alexander 1982; Hall 1996b; Reagan et al. 1978; Stanford 1979; Wisner 1996). It is generally assumed that the initial settlement of South America resulted from one or more groups passing through North America via the Beringian Corridor or a North Atlantic route, either by land, boat, or some combination of the two. Unless they passed quickly through North America and ultimately settled in South America (Anderson 1990b:164), it is perhaps only a matter of time before substantiating evidence for pre-Clovis

in North America is discovered. As could be expected, the evidence for pre-Clovis will be difficult to locate, scant, and the subject of intense scrutiny.

PALEOINDIAN (11,600–10,000 B.P.)

Paleoindian Chronology: Status and Problems

The chronology of the Paleoindian stage is a topic of active concern and much ongoing debate. In the west, the tripartite subdivision once corresponded relatively well with Clovis (Llano), Folsom, and Plano, but definition of the Goshen complex by Frison (1991, 1996) has muddled this simple unilinear cultural sequence. A similar, somewhat arbitrary tripartite sequence is often used for the Eastern Woodlands, with Early, Middle, and Late Paleoindian corresponding roughly to ca. 11,500–10,900, 10,900–10,500, and 10,500–10,000 B.P., respectively (Anderson 1990b, 1995a, 1995b; Anderson et al. 1996; Roosa and Deller 1982). Recent ^{14}C determinations from the Aubrey Clovis site in Texas indicate that the dating for Early Paleoindian should be pushed back to at least 11,600 B.P. (Hall 1996a). Even so, most widely accepted dates from sites in the East extend no further back in time than Middle Paleoindian, or contemporaneous with Folsom (Haynes 1987; Haynes et al. 1984). Nonetheless, some recently investigated sites in the East have produced dates that rival or even exceed Early Paleoindian dates from the West—e.g., the Paleocrossing site in Ohio (Brose 1994) and the Hiscock site in New York (Laub 1995a, 1995b).

The three periods in the East are thought to coincide with occurrences of: (1) Clovis and eastern fluted lanceolate forms like Gainey or Bull Brook; (2) fluted and unfluted lanceolate forms with modified bases such as Cumberland, Quad, and Parkhill; and (3) typically unfluted, notched and unnotched lanceolate forms such as Dalton, San Patrice, and Holcombe (Anderson 1995b; J. Morrow 1996; Roosa and Deller 1982). At least in Missouri, such a sequence may not have validity, as Dalton may have evolved directly from Clovis (O'Brien and Wood 1998).

Despite a proliferation of Paleoindian research in the last decade, the dating of these early deposits and artifacts in most of eastern North America, particularly for the Early and Middle periods, is still based on a relatively small number of absolute dates, and most of these derive mainly from Paleoindian sites in the Northeast and the Great Lakes. Adequate suites of ^{14}C assays are also typically lacking (see Levine 1990; J. Morrow 1996).

A thorough study of Paleoindian radiocarbon dates was undertaken by Levine (1990), who reevaluated 62 dates from Debert and 11 other Paleoindian sites in the Northeast. In generalizing about this entire set of dates, she concluded that "they do not offer the resolution necessary to date the Paleoindian occupation of the Northeast to a temporal unit finer than the 11th millennium" (Levine 1990:59). Of course, this conclusion is biased by the inclusion of an amalgamation of sites that probably represent a millennium or more of Paleoindian prehistory, but she was correct in her parting plea for more carefully collected, well-provenienced radiocarbon samples from individual sites. The only site for which she could provide relatively fine resolution is Debert. Based on 29 dates from 10 hearths, Levine (1990:47–50, 59) contends that there is a 95% chance that at least parts of Debert were occupied between 10,600 B.P. and 10,700 B.P. The occupational spans for all other sites with seven or fewer dates were no less than 1,200 years, hardly sufficient to begin establishing a sound chronology.

Several factors have contributed to the paucity of dates and our poor understanding of the relative temporal position of typologically and regionally distinctive artifact assemblages. First, most Paleoindian sites in eastern North America have exhibited poor overall preservation of dateable organic materials. The lone exception east of the Plains is the Debert site in central Nova Scotia, which was characterized by relatively large amounts of charcoal in hearths (MacDonald 1968). Second and related, archaeological excavations at many Paleoindian sites were undertaken prior to development of accelerator mass spectrometry (AMS) dating and systematic flotation of sediments. Since standard dating methods required relatively large quantities of organic materials, small bits of scattered organic remains likely would not have been documented and collected.

Third, greater advances in developing regional sequences have been hindered by the absence of sites with stratified Paleoindian deposits. Many of the better-known Paleoindian sites in eastern North America occur in upland contexts, on high stream terraces, or on ridges of glacial lake beaches that exhibit little soil development, negligible preservation of organic materials, abundant postdeposi-

tional pedoturbations or even deflation, and subsequent uses and disturbances by later prehistoric occupants. Exceptional sites in alluvial settings south of the Canadian border include Thunderbird (Gardner 1974, 1977, 1983), Shawnee Minisink (McNett 1985), Quince (Perttula 1985), Big Pine Tree (Goodyear 1997; Goodyear and Foss 1992), Harney Flats (Daniel and Wisenbaker 1987), and Saltville (Wisner 1996), among the most notable. Even so, the Paleoindian components of virtually all of these sites have not yielded internally reliable chronostratigraphic evidence. Most of these sites were characterized by a thin Paleoindian horizon overlain by later Archaic and/or Woodland horizons.

Stratified deposits with Paleoindian horizons also have been identified at a number of cave and rockshelter sites such as Meadowcroft (Adovasio et al. 1990; Adovasio et al. 1978, 1982), Dust Cave (Driskell 1992, 1994, 1996), Graham Cave (Klippel 1971; Logan 1952), and Rodgers Shelter (Kay, ed. 1982; McMillan 1971; Wood and McMillan 1976). Except for the disputable deep deposits (Strata I-IIa) at Meadowcroft Rockshelter, however, existing reports indicate that the occupations of these sites were typically initiated during the Late Paleoindian period. Nevertheless, a recent reassessment of materials from Rodgers Shelter has resulted in the suggestion of limited pre-Dalton utilization of this site (Marvin Kay, personal communication 1997). In general, however, relatively undisturbed, buried Early and Middle Paleoindian deposits have been found wanting or controversial.

As a consequence of the limited number of dates and the lack of stratified Paleoindian sites, diagnostic bifaces and other tools in surface collections and from single-component sites have been assigned to the largely heuristically devised periods based on seriation, underpinned by preconceived notions about changes in form and technology. For example, Gainey bifaces, which are considered by most eastern North Americanists to be an Early Paleoindian type and perhaps the immediate successor of the Clovis type, lack a single associated noncontroversial ^{14}C date. It is considered an early type based principally on size, fluting technique, and overall shape.

Confounding efforts to make chronological sense of the Paleoindian record in eastern North America is the time-transgressive nature of various complexes and the emergence of regional traditions. As Anderson (1995a:4) aptly notes, probable Middle Paleoindian assemblages in the Southeast had already become distinctively different from their presumed counterparts in the Midwest and Northeast. Our understanding of what constitutes Middle Paleoindian in some areas of eastern North America is enigmatic due to the overall lack of radiocarbon dates and excavations at stratified sites. For example, a Late Paleoindian Hardaway-Dalton complex or phase has been repeatedly confirmed throughout much of the Southeast (e.g., Anderson 1995a, 1995b; Ensor 1985, 1986; Goodyear 1982; Morse 1997; Morse and Morse 1983). In at least the western part of southeastern North America, Dalton may have developed directly from the earlier Paleoindian fluted forms (Goodyear 1982; Morse and Goodyear 1994). In support of a much longer and earlier lifespan (Middle-Late Paleoindian) for the Dalton complex is the fact that Dalton and some other bifaces are occasionally fluted, though most are only basally thinned (Chapman 1975; Hofman and Wyckoff 1991). Despite the better record for Dalton, the chronological span encompassed by this biface type is still a matter of some debate (e.g., see recent discussion by O'Brien and Wood [1998:80]). It may have been a long-lived style with typologically distinct variants extending into Early Archaic times (e.g., Wyckoff 1985, 1989).

Paleoindian Settlement, Subsistence, and Chert Exploitation

A number of substantial Early-Middle Paleoindian sites have been defined in the Great Lakes and Northeast areas (e.g., see Deller 1989), but most similar-aged nonquarry sites in the Southeast are represented by only a few points or isolated specimens that are indicative of relatively transient activities by smaller aggregates of people (Meltzer 1984, 1985; cf. Smith 1990). Even so, the county-by-county abundance of diagnostic bifaces in some portions of the Southeast rivals or exceeds those reported from more northern latitudes, implying that overall population densities were similar if not greater in the south (Anderson 1990a, 1991; Faught et al. 1994). One explanation for the seemingly more diffuse distribution of fluted Paleoindian bifaces in lower latitudes is offered by Meltzer and Smith (1986), who argue that a more generalized foraging pattern was most optimal for exploitation of the taxonomically richer environs of the Southeast (also see Meltzer 1984, 1985, 1988). In contrast, the more northern tundra and spruce parkland had

low species diversity, yet the abundance of preferred resources (e.g., caribou) was high and their patterns of movement were relatively predictable. As such, larger groups of people could repeatedly utilize key or predictable locations where considerable amounts of biomass would be exploited (but see Shott 1990 for an alternative explanation). The presence of caribou remains at several sites (Bull Brook, Holcombe Beach, and Whipple) in the Great Lakes and Northeast would appear to provide some support for Meltzer's assertion (see Spiess et al. 1985), but good subsistence data are lacking.

The traditional "diet-centered" model of Early Paleoindian adaptation is of highly mobile bands that moved from place to place as preferred resources were depleted and new supplies of resources were sought (e.g., Kelly and Todd 1988; Mason 1962). An implicit assumption of this model is that Clovis bands were initial colonizers of essentially unrestricted, broad areas. These bands were also principally engaged in hunting megafauna species characterized by small populations that required relatively lengthy recovery periods and, therefore, were easily subject to extinction. The association of mastodon and other megafauna remains with Clovis lanceolates and other tools at the Kimmswick site in eastern Missouri provides some of the best evidence for megafauna exploitation in eastern North America (Graham 1986; Graham et al. 1981; Graham and Kay 1988). These deposits also contained remains representing "all vertebrate classes," including 23 species of mammals as well as bones of fish, amphibians, reptiles, and birds (Graham and Kay 1988:232). At least in the Southeast and Midwest, subsistence strategies are now believed to have been fairly diverse, with exploitation of smaller game, perhaps mussels and fish, and greens, seeds, fleshy fruits, and underground parts of plants (e.g., rhizomes, tubers, and corms). If this were the case, then group movements would have been strongly influenced by seasonal cycles of availability within established territories.

Unfortunately, faunal, botanical, and human-biological evidence for Paleoindian subsistence is extremely meager for eastern North America. Despite the record at Kimmswick, it should also be emphasized that this may represent a relatively specialized kill/butchering site. The lack of good subsistence data is probably due to the generally poor preservation conditions that typify the old, highly weathered deposits wherein Paleoindian refuse is normally found. The record for later Paleoindian subsistence is slightly better but still poor and largely conjectural. In general, it is assumed that greater diversification in exploitation, population growth, and divergence in regional traditions attended the rapidly changing terminal Pleistocene to early Holocene environment.

Given the typical absence of material remains other than lithic debris at eastern North American sites, many Paleoindian researchers have taken a "lithocentric" perspective on settlement and mobility (e.g., Gardner 1977; Goodyear 1989). Coining such a term is not meant to demean the importance of lithic raw materials in affecting mobility, range, and settlement location, but instead to draw attention to other factors such as social considerations (e.g., procurement of mates, reification of intra- and intergroup alliances, etc.) and locations of relatively nonmobile, harvestable resources (e.g., cat-tail stands, nut-tree groves, mussel beds, and fish). A number of factors, not just lithic sources, may have had important effects on determining group movement and settlement location (Shott 1986, 1989a, 1989b, 1990). This is especially true for nonglaciated areas such as the Ozarks, where lithic raw materials are widely distributed and plentiful, in contrast to most glaciated regions, where only small pebbles and cobbles are usually available and even these are scarce.

The perspective that lithic source areas were central elements of Paleoindian settlement-subsistence and mobility has had nearly universal appeal, and topics of procurement, distribution, processing, and utilization of lithic materials have been the focus of much Paleoindian research (e.g., Goodyear 1989; Haynes 1980, 1982; Meltzer 1985; Smith 1990; Tankersley 1989, 1990, 1991). It is readily apparent that there was considerable selection for high-quality cryptocrystalline material. The presence of exotic stone also is common at many Paleoindian sites, although the direct vs. indirect procurement of these materials is unclear. Some of this material occurs at sites far removed from their source, requiring a regional to panregional understanding of geological context, surficial availability, and macroscopic or microscopic means of identification.

Paleoindian in the Ozarks

Over 20 years ago, Chapman (1975:Figure 4–3) demonstrated that relatively few fluted points had been documented for the Ozarks region of Missouri. This apparently has changed little (O'Brien

and Wood 1998). At the time of Chapman's distributional study, fluted points were not documented for about one-half of the counties in the Ozarks. The collections at the Center for Archaeological Research, Southwest Missouri State University, which include well over 50,000 hafted bifaces or proximal fragments, contain only four examples of fluted bifaces, at least two of which appear to represent transitional Clovis-Dalton forms. For the eastern part of Oklahoma (the western fringe of the Ozarks) Hofman and Wyckoff (1991:29) report only three Clovis points. Hofman (1996) also reports a paucity of Early Paleoindian points in southeast Kansas, and a similar situation is evident for the Arkansas portion of the Ozarks (Sabo and Early 1988:36).

The relative paucity of Early and Middle Paleoindian sites in the Ozarks can be attributed to a combination of factors. First, most of the rugged Ozarks are either forested or in pasture, thereby limiting surface visibility and artifact-collecting activities. Second, many sites may be inaccessible or unexposed due to deep burial in alluvial settings. Third, many Paleoindian sites have been destroyed by postdepositional alluvial processes during the Holocene. This is probably more true for those streams draining into the White, St. Francis, and Mississippi rivers than for those emptying into the Osage and Missouri rivers. Fourth, many of the earliest deposits in caves and rockshelters are rarely explored because of their great depths and the large amounts of roof breakdown encountered. Consequently, many of the earliest deposits at these sheltered sites are perhaps sealed by large blocks of ceiling fall. Fifth, although Chapman (1967a, 1967b, 1973) did provide a preliminary inventory of fluted points for the state, an active, long-term Paleoindian research program has never been implemented for the Ozarks.

The record for Late Paleoindian in the Ozarks is substantially better. In fact, the number of unfluted Dalton points in public and private collections from sites in the southwestern Ozarks is many times greater than that for fluted points. This is duplicated throughout the Southeast (e.g., McGahey 1996; Morse 1997; O'Brien and Wood 1998; O'Steen 1996). Sheltered sites appear to have been used consistently for the first time (Walthall 1998b), and Dalton materials occur in a wide variety of settings suggestive of generalized foraging and increased localization in resource procurement. The greater abundance of Dalton points, and therefore of Dalton sites, is suggestive of a major increase in population during the Paleoindian stage. Unlike earlier fluted points, Dalton points also have been recovered from a number of buried alluvial contexts in the western half of the Ozarks. These include the Dalton site in central Missouri (Chapman 1975), as well as several other sites along the western flank of the Ozarks extending from west-central Missouri to northwest Arkansas (e.g., Dickson 1991; Eschbacher 1992; Kay, ed. 1982; Wood and McMillan 1976; Wyckoff 1985).

ARCHAIC

Archaic sites are generally perceived of as representing the manifestations of bands of nomadic or semi-nomadic hunter-gatherers. During the Early Archaic period (10,000–8000 B.P.), projectile-point styles diversified somewhat, indicating increased cultural regionalization, population growth, and territorial reduction. Projectile-point types representative of the Early Archaic period in this region include Graham Cave Side Notched, Cache River Side Notched, Hardin Barbed, Rice Lobed, Searcy Lanceolate, Hidden Valley Stemmed, and Jakie Stemmed, among the most notable. The best known Early Archaic sites in Missouri tend to be caves and rockshelters, since such sites often exhibit relatively good preservation and were repeatedly reoccupied over thousands of years (e.g., Graham Cave, Arnold Research Cave, and Rodgers Shelter). Open-air sites are substantially more common, but they have received far less archaeological attention.

Our knowledge of the Early Archaic period in the Sac River valley is essentially nonexistent. Early Archaic points have been found at several sites, but no excavation of an Early Archaic site or component has been undertaken to date in this valley, other than the limited work at the Montgomery site. As Chapman (1975:130) remarked:

> No solid evidence of Forager occupation during the Early Archaic period could be found in the Upper Osage Locality in the western part of the state, even though several caves and shelters were excavated in the Kaysinger Bluff [now Truman] and Stockton Reservoir areas, and most of them were dug to what was considered to be sterile soil.

Paleoindian and Archaic components were not clearly defined at any sites examined in the Stockton Lake area prior to impoundment, although a

lanceolate point (probably Searcy) and a lobed point (Rice Lobed) were recovered from the deepest artifact-bearing deposits at Toler Cave (Wood and Pangborn 1968:8, 10).

Rodgers Shelter in the adjacent Pomme de Terre River valley is the only site that provides some glimpses into Early Archaic adaptation in this region. Two separate "living surfaces" and nine cultural features were found in Horizon 8, which is assumed to have postdated Dalton or Late Paleoindian use of the site. This horizon is dated to the end of the Early Archaic period by Kay (1982a:586). The features included six hearths, a scatter of bones and artifacts, and a cache of five antler tines. The scatter of bones and artifacts included a Rice Lobed point with skeletal remains of bison, deer, turkey, cottontail rabbit, squirrel, box turtle, dog/coyote, and freshwater drum (Kay 1982a:570). Hickory nut shell also was recovered from Horizon 8 (King 1982a:Table 6.5). Remains of these animal and plant resources reflect exploitation of a relatively wide array of habitats, including the river itself as well as prairies and forests.

The Middle Archaic period (8000–5500 B.P.) is generally perceived as a difficult time, coinciding with the dryer and warmer Hypsithermal Interval. Again, little is known about this period in the Sac River valley, but most authorities would agree that human adaptations to the changes in biotic conditions during the Hypsithermal involved resource diversification and, in places, increased sedentism in particularly rich floodplain environments (see Brown and Vierra 1983). Following the extant thinking on mid Holocene adaptations, Perttula and Purrington (1988:46) argued for a shift towards more intensive exploitation of the Sac River bottomlands and the utilization of floodplain localities in proximity to critical resources such as nuts and perhaps fish. That is, the pronounced and long-term effects of the Hypsithermal in the region compelled hunter-gatherers to abandon many upland localities in favor of the major river valleys, in this case the lower Sac River valley. Evidence for the effects of the Hypsithermal on settlement-subsistence activities has been documented by McMillan (1976a) and supported by subsequent work in the adjacent lower Pomme de Terre valley (Kay, ed. 1982).

Projectile points typically assigned to this period include various side-notched forms such as Big Sandy and White River. Such points, however, probably date primarily to the last half of this period, or perhaps no earlier than about 6000–6500 B.P. Numerous points from Rodgers Shelter also are assigned to this period (Kay 1982e), but many of the types are considered to date to the Early Archaic and even Late Paleoindian periods elsewhere (e.g., Rice Lobed, Kirk-like, Hidden Valley, LeCroy, Rice Lanceolate [Searcy], Dalton-like, and the St. Johns Variant of San Patrice). A number of these point types also occur in as many as four or five different horizons (Kay 1982a:Table 11.1). This calls into question the clarity of the Middle Archaic horizons at Rodgers Shelter. The abundance of uncarbonized seeds throughout the horizons in both the main excavation area associated with the shelter and in the west terrace deposits is indicative of a considerable amount of contamination from bioturbation (see King 1982a:Table 6.2).

Horizons 5 and 6 at Rodgers Shelter are representative of the Middle Archaic period. The only clearly delineated features in these two horizons were four hearths, a dog burial, and a potential cache of two antler tines. Assuming that many of the faunal and floral remains in the two horizons were deposited during the Middle Archaic period, we can assert the following. Aquatic resources, particularly slackwater fishes, became very important during this period. The exploitation of mussels also generally increased from about late Early Archaic times (i.e., beginning with Horizon 7) to Woodland times, or during the Middle and Late Archaic periods (Klippel et al. 1982). Exploitation of deer, cottontail rabbit, and squirrel perhaps achieved even greater importance than in earlier times (see Purdue 1982:Table 9.3). Plant remains include carbonized seeds of persimmon and black cherry, as well as hickory nut shell (King 1982a:Tables 6.4–6.5).

The Late Archaic period (5500–3000 B.P.) is amply represented in the lower Sac River valley. This could be attributed in part to the ameliorating climatic conditions characterizing the late Holocene, in addition to general population growth. However, the abundance of Late Archaic sites relative to earlier ones is also partly due to the fact that earlier sites in the floodplain proper have been buried by aggrading late Holocene alluvium. In any regard, archaeological evidence from survey and testing work in the lower Sac River valley seems to indicate that people were abundant during Late Archaic times and, despite the inherent biases in our data base, probably more populous than during preceding portions of the Archaic stage. During the Late Archaic period, the improved climatic conditions

and re-expansion of the oak-hickory forests stimulated resettlement of the uplands. The floodplains were not abandoned, however, and most of the major base settlements probably remained in the vicinity of meander channels, the river itself, and other wetland habitats, either on terraces or alluvial fans.

Some of the types of projectile points characteristic of this period are Smith Basal Notched, Stone Square Stemmed, Etley Stemmed, Table Rock Stemmed, Nebo Hill and Sedalia Lanceolates, and several different corner-notched types (e.g., Williams, Castroville, and Afton). The proliferation of types during the Late Archaic period probably reflects a combination of the increasing localization of regional cultural identities and the heightened pace of cultural change. By the end of the Late Archaic period, there was a general decrease in projectile-point size, and some points are small enough to be classified as arrowpoints (e.g., Parisi 1985:96, 102), although they were likely just small dart points. Lithic-procurement strategies also became increasingly localized, an expected pattern given the greater pressures on resources due to a growing regional population and the diminishment of group territories.

Hunting and gathering apparently continued to be the dominant modes of food procurement undertaken by most Late Archaic groups. Because of increased population and concomitant reductions in territory sizes, a subsistence strategy based on an even more diverse array of resources than that of Middle Archaic times was adopted (Ford 1974). In addition, some plants were cultivated, or at least initially encouraged in protected areas, and apparently became increasingly important during this period. These include bottle gourd and squash, both of which have been recovered from Late Archaic contexts at Phillips Spring in the lower Pomme de Terre River valley (Kay et al. 1980; King 1985). Although the initial importance of these cucurbits may have been less as food items and more for utilitarian purposes (e.g., as containers, dippers, and net floats), other evidence from the Ozarks (Fritz 1986, 1997) and elsewhere in the Midwest clearly shows that an indigenous complex of plants was being cultivated in many places by Late Archaic populations. This indigenous complex minimally included sunflower, marsh elder, chenopod, and perhaps ragweed.

The initiation of ceramic production in eastern North America also appears to have occurred during the Late Archaic period, and some of the best evidence for the early production of pottery in eastern North America is derived from Missouri and adjacent states. Native Americans of the Nebo Hill phase near modern-day Kansas City apparently made thick, fiber-tempered pottery that may have been used to insulate simmering meat stews (Reid 1983, 1984). In any regard, the initial appearance of ceramics may have been localized and short-lived. At least in portions of the Ozarks, pre–Late Woodland ceramics tend to be rare, which could reflect greater mobility of populations in hillier portions of the Ozarks.

Relatively extensive trade also was undertaken among some Late Archaic populations, although groups in the lower Sac River valley may have been on the periphery of these exchange networks. For example, most of the galena from the Poverty Point site in Louisiana originally derived from the Potosi deposit in the eastern Ozarks (Walthall et al. 1982). Community ceremonial facilities also appear for the first time. The most extreme example is the earthwork complex at Poverty Point. However, some of the burial mounds in the nearby Pomme de Terre drainage also have definite Late Archaic components (Wood 1961:88–89, 102).

Development of Sedentism During the Archaic

The development of sedentary behavior in the Midwest has emerged as a theoretical issue of considerable interest to archaeologists. More recent models concerned with the development of sedentism have relied extensively on Binford's (1980) distinction between: (1) residential mobility, in which foragers move in residential bands to seasonal camps adjacent to resource patches; and (2) logistical mobility, in which inhabitants of sedentary sites send small work parties out to extract and process resources. Foragers, as exemplified by the San and several societies in tropical forests, typically move from one patch of resources to another. From temporary camps, they seek food daily on an encounter basis. The resulting sites consist of residential bases and extraction locations. Length of occupation and the frequency of reuse of choice locations for resi-

dential bases will condition archaeological visibility to a large extent. Extraction locations, because of the short period of occupation and low amount of debris discard, would be almost invisible archaeologically unless they were repeatedly reused.

In contrast, logistically organized collectors, as exemplified by the Nunamiut, tend to exhibit less residential mobility. Work parties from residential bases make trips to process specific resources in bulk and store the excess. Thus, the residential base appears as the hub of a wheel, in which the spokes represent the movement of work parties. The society can be adjacent to one group of resources but still exploit distant ones without having to move the entire population.

Debate has continued over the timing of the shift from residential mobility to logistic mobility in various regions of the Midwest. Although often oversimplifying the debate by invoking a time-transgressive, multilinear evolutionary theme, most researchers do recognize that such a shift did not occur simultaneously throughout the Midwest and that changes in some regions sometimes involved shifts back to residential-mobility strategies. Still, the general change from residential to logistical mobility is one that most researchers envision as a stage toward greater sedentism, which in turn correlates with substantial population growth and increasing sociopolitical organization. To many, the establishment of logistic-mobility strategies also correlates generally with early stages of horticulture and greater dependence on harvestable aquatic resources, particularly fish and mussels. Such aquatic products were sufficiently predictable and abundant in some riverine locales to permit a high degree of sedentism.

Almost certainly, early Paleoindian societies were nomadic and most Woodland societies were sedentary. However, researchers differ as to when the shift occurred from nomadic lifeways to more sedentary ones. Depending on the data and the often quite diverse notions about the relevance of those data, sedentary lifestyles are thought to have first appeared during Late Paleoindian or Dalton times (Morse 1977), the Early Archaic period (Lewis 1983), the Middle Archaic period (Brown and Vierra 1983; Charles and Buikstra 1983), and the Late Archaic period (Emerson et al. 1986; O'Brien 1980; Reid 1983). In turn, other researchers (Cook 1986; Sabo et al. 1990) suggest that at least some Late Archaic populations were nomadic or no more than semi-sedentary. Several synchronic and diachronic models have been advanced to explain settlement strategies and the development of sedentism in the Midwest. The applicability of such models, or aspects thereof, to the Sac River valley and the region as a whole remains to be evaluated.

WOODLAND

Woodland tradition sites, especially mounds and villages, are numerous throughout the Sac River valley. However, that does not mean the Woodland tradition is well understood or even well documented. Most archaeological work has focused on burial mounds (Bradham 1963; Wood 1967; Wood and Brock 1984), so we know little about most aspects of everyday life.

Based on the number of Woodland sites documented in the lower Sac River valley, there is good reason to believe that the regional population continued to grow after the Archaic stage, culminating perhaps during the Late Woodland period. Nevertheless, essentially no clear-cut evidence for the Early Woodland period (3000–2200 B.P.) in the Sac River area has been obtained. In fact, it is unclear when the Woodland tradition appeared in the Ozarks in general. Although nowhere abundant, the types of ceramics found elsewhere in the Midwest during the Early Woodland period seem to be entirely lacking in the Ozarks. As a consequence, Chapman (1980:9–10, 22–26) argued that the Archaic (Forager) tradition continued in the region well into the Middle Woodland period. He further suggested that the Early Woodland sites, where present, consisted of "small, ephemeral hunting-collecting campsites rather than base camps" (Chapman 1980:10). This summarizes a long-held stance among many archaeologists that the western Ozarks were culturally isolated. Sites either reflect short-term intrusions by groups from nearby areas or they reflect small, indigenous societies that did not maintain extensive relationships with surrounding groups. These small groups lagged in the rate of cultural change, accepting innovations only slowly and conservatively (cf. J. Brown 1984). As Willey and Phillips (1958:124–125) claimed, "it is a remarkable fact that the culture of a region [the Ozarks] so close geographically to the centers of maximum intensity of Formative development in the Mississippi Valley has been so impervious to cultural influences from these centers."

The difficulty in identifying cultural manifestations dating to the Early Woodland period stems

partly from the lack of reliable dates on diagnostic bifaces found in good contexts and partly from the paucity of ceramics in general at Woodland sites in the region. Such problems continue to be endemic to the Ozarks, especially for the Early Woodland period. Chapman (1980:18) commented "there is little need to look at the [Early Woodland] data region by region, because the evidences are too scanty and their chronological placement is too uncertain." More recently, O'Brien and Wood (1998:170) wrote:

> Unfortunately, things have not changed much in the decade and a half since Chapman published his overview. Most of what we know of the Early Woodland period in Missouri comes from a few sites in the Mississippi River valley below Cape Girardeau and from a few sites in the Missouri River valley. Likewise, much of what we know about the Middle Woodland period comes from scattered sites in the Mississippi River valley and from two locations in the Missouri River valley—one centered on Saline County in central Missouri and the other just north of Kansas City.

One of the unfortunate problems besetting research on the Early Woodland period is that the ceramics produced by some Early Woodland peoples were often poorly fired and very friable, falling apart readily. It is also true that ceramics probably were used on an incidental basis only in some areas during the Early Woodland period and not at all in others (see Brown 1986). Furthermore, we may have been looking in the wrong places (Griffin 1986), in addition to looking for the wrong signatures (i.e., pottery) of sites dating to the Early Woodland period. Many groups living during this time apparently continued their relatively mobile hunter-gatherer lifeways, using perishable basketry instead of heavy and friable (essentially nonportable) ceramic vessels. Other diagnostic artifacts, such as projectile points, may have been of the same styles as were produced during Late Archaic and Middle Woodland times. That is, a particular projectile-point type specific only to the Early Woodland period may simply not exist. Consequently, the concept of an "Early Woodland" may have no relevance as the beginning of the Woodland tradition, long ago established as a concept to mark the beginning of ceramic production, the inception of mound building, and the process of plant domestication. As a temporal span of time, however, it will likely persist.

Except for finding the occasional decorated Havana or Hopewell sherd, or a Snyders-like point, we also know little about the Middle Woodland period (2200–1500 B.P.). Two of the best known sites in the Sac River valley, Flycatcher and Dryocopus Village, have been interpreted as Late Woodland or Mississippian settlements (Chapman 1980; Calabrese et al. 1969; O'Brien and Wood 1998; Pangborn et al. 1971). Features at the two sites included circular to oval single-post structures, basin-shaped pits, cylindrical pits, and hearths. Both sites yielded a wide array of Late Archaic through Late Woodland/Mississippian point types, but pottery was lacking.

There are a number of potential problems with both sites, and it could be argued that the structures and at least some of the other features perhaps date to the Middle Woodland period and not later as has been commonly accepted.

First, the absence of ceramics does not mean that pottery was not used by the occupants, whether Middle Woodland, Late Woodland, or Mississippian. However, the probability that pottery would not be found at a Woodland settlement in this region is more likely for a Middle Woodland site than it is for a Late Woodland site. The only certain Middle Woodland pottery found to date in the Stockton Lake area consists of a small handful of decorated sherds from Rockhouse Cave (23SR21), Taterhole Cave, Griffin Shelter, and site 23CE417 (Chapman 1980:26–27;Moffat and Houston 1986:143). Second, the wide array of Late Archaic through Late Woodland/Mississippian point types represented at both sites is quite consistent with the mélange found at most other sites on or in late Holocene terrace fills in the lower Sac River drainage. Yet, all of the features at both sites are considered by previous researchers to represent single components. Given that the sites were used intermittently throughout the late Holocene, particularly earlier than the Late Woodland period, it seems reasonable to think that some of the pits were not necessarily contemporaneous with the structures or with each other.

Third, the assignment of all features at these sites to the Late Woodland period hinges entirely on accepting only three radiocarbon dates (as noted below, however, actually only one date is considered roughly accepted). The three dates include one

from Feature 63 at Dryocopus Village (23CE120). This pit feature was located about 20 m to the west-southwest of House 2 (Calabrese et al. 1968:39). It produced an uncalibrated date of A.D. 1485 ± 100 (derived from the combination of two samples: M-2024 and M-2025). Two dates were obtained for the Flycatcher site: one is from an unspecified context in House 3 and the other is from a pit feature. The respective uncalibrated dates are A.D. 715 ± 95 (GXO-750) and A.D. 1390 ± 100 (M-1899). The dates of A.D. 1485 and 1390 are generally considered too young, whereas the date of A.D. 715 is considered to be closer to the mark, although perhaps about 200–300 years too old (O'Brien and Wood 1998:267–268). It could be argued that none of these dates accurately reflects the period when these structures and presumably some or most of the features were used.

Fourth, both sites are dominated by contracting-stemmed projectile points/knives, although points from Dryocopus include an array of many different kinds. Even so, the most abundantly represented type at Dryocopus is the Langtry Contracting Stemmed point (Calabrese et al. 1968:Plates 1–3), whereas those from Flycatcher are dominated by Gary and/or Waubesa points (Pangborn et al. 1967:Figures 4–6). It would seem logical, therefore, to assume that the features relate to the period when such points were utilized. Elsewhere in the Midwest, contracting-stemmed types, such as Belknap, Burkett, Dickson, and Gary, are considered to date to the Early Woodland and Middle Woodland periods (e.g., Farnsworth and Emerson 1986; O'Brien and Wood 1998). At Rodgers Shelter and Blackwell Cave, Gary points were found associated with grit-tempered and limestone-tempered Middle Woodland dentate-stamped pottery (Wood 1961). The small number of existing dates for Langtry points also indicates that this type dates to the Middle Woodland period. These include uncalibrated dates of: (1) A.D. 60 ± 50 on nutshell from Level 9 in Stratum III in association with four Langtry points at the well-stratified John Paul Cave (23CN758) (Ray 1995b:Table 3); (2) A.D. 70 ± 60 on 10 g of a human femur from an infant burial with a Langtry point resting, presumably placed, on the chest of the skeleton at Little Indian Rockshelter (23SN921) (Ray 1994a); and (3) 230 ± 120 B.C. from a mass of charcoal containing the proximal fragment of a Langtry point at Cobb Cave (23CN71) (see Benn and Lopinot 1993; unpublished field records). It is also interesting to note that what appears to be a Langtry Contracting Stemmed point (identified by the authors as a Gary) was found associated with a dentate-stamped sherd in Level 4 (i.e., in situ in sub-plow-zone context) at 23CE417, located less than 2 km upstream from the Big Eddy site (Moffat and Houston 1986:141).

In other regions of the Midwest, but particularly west-central and southwestern Illinois, we know that most of the population in Middle Woodland societies lived in small hamlets and practiced horticulture, if not agriculture (e.g., Bareis and Porter 1984; Smith 1992). Settlements of these groups were often situated on terraces of streams in proximity to fertile soils. In central Missouri and the Ozarks, the deceased were often interred in earthen mounds and stone cairns on nearby bluffs, but individuals were also sometimes buried in open villages, rockshelters, and caves. The latter two features were probably also used as short-term campsites, as storage facilities, and for traps (cf. J. Brown 1984:49–52).

The Late Woodland period (1500–1000 B.P.) is represented by more sites in the lower Sac River valley than any other period (see Table 1.2). Despite the abundance of such sites, our knowledge of Late Woodland activities and change are negligible for the Sac River valley. The Late Woodland period was traditionally considered to be a time of cultural regression by archaeologists working in eastern North America. This is due to the limited ceramic decorative diversity and lack of evidence for long-distance exchange of exotic goods, both of which are well represented in the preceding Middle Woodland and succeeding Mississippian periods. Such a perspective is now considered untenable. The Late Woodland period was a time of considerable change and explosive population growth. The bow and arrow was introduced during the early part of this period, perhaps leading to increased hunting efficiency as well as warfare (Ford 1974). Maize agriculture also became a dominant mode of subsistence during the later part of this period in some areas.

Most Late Woodland sites in the Sac River valley have been identified based on the presence of Scallorn arrowpoints, Crisp Ovate arrowpoints or preforms, and Rice Side Notched and Kings Corner Notched dart points/knives. Grit-tempered pottery, which is less common, occurs at a number of sites and appears to be representative of at least one Late Woodland complex. The grit-tempered pottery perhaps is best subsumed as Lindley phase

pottery, defined from collections in the nearby Pomme de Terre area (Chapman 1980:91–93; Wood 1961). Lindley pottery is primarily limestone or chert tempered (more rarely sand tempered) with smooth, as well as cordmarked, exterior surfaces. Lindley phase groups utilized river terraces, rockshelters, and caves (Chapman 1980:92). The abovementioned projectile points, along with the Gary and Langtry Contracting Stemmed types, are considered to be representative of the Lindley phase (Wood 1961), but such an association has not been adequately established.

The other possible Late Woodland culture represented in the Sac River valley is Pomona (Carlson 1983; O'Brien 1984; Roper et al. 1977). Pomona is a variant of the Plains Village tradition that occurs in western Missouri and eastern Kansas. It has been termed a "Late Plains Woodland manifestation" (Witty 1981), but Pomona sites typically date after A.D. 1000 during the Mississippian period. Grog-tempered Pomona pottery does occur in the western Ozarks, including the Sac River valley (K. Brown 1984; Yelton 1981:33–39). The exteriors are usually cordmarked, although Pomona vessels can also have smooth surfaces. K. Brown (1984) considers plain-surfaced pottery from the Truman Lake region to be Pomona as well. Pottery that he considered as Pomona from four sites in the Truman Lake area (K. Brown 1984:149) includes plain-surfaced (76.7%) and cordmarked (23.3%) varieties. Tempers include both grog and shell.

Compared to open-air sites, a relatively abundant number of professional excavations have been undertaken on the earth-and-rock mounds and rock cairns in this region. Two burial complexes have been defined in the region that apparently have their roots in the Late Woodland period, or perhaps earlier, and extend into the Mississippian period. These are the Bolivar burial complex, defined principally from rock cairns excavated in the Stockton Lake area (Chapman 1980:150–152; Wood and Brock 1984), and the Fristoe burial complex, defined primarily from the rock cairns and earth-and-rock mounds excavated in the Truman Reservoir area (Chapman 1980:93–99; Wood 1961, 1967). Mounds of the Bolivar complex contain primary burials, bundle burials, cremations, and scattered secondary remains. The most common projectile points found in these mounds are Scallorn arrowpoints and Rice Side Notched darts/knives, demonstrating that these tumuli were constructed primarily during the Late Woodland period. The ceramics are likewise mostly from limestone-tempered wares, although some grog-tempered and shell-tempered pottery also may be present. The Bolivar complex mounds also often contain charred plant remains, principally nuts and maize.

MISSISSIPPIAN

The Mississippian period (1000–300 B.P.) is represented in most parts of the Midwest by the presence of shell-tempered pottery and triangular arrowpoints (e.g., Madison, Reeds, and Cahokia arrowpoints). However, the Sac River valley is again situated in a sort of "no-man's land" lying between the heartlands of several Mississippian period traditions. These include Pomona to the west, Caddoan to the south, and Steed-Kisker to the north-northwest. By later Mississippian times (minimally ca. 600–400 B.P.), Neosho groups were present in the general region to the south and southwest, whereas Oneota groups had become well entrenched to the north along the Missouri River. By the time of the first recorded contact of Native American groups with the French, the Osage comprised the most important aboriginal group in west-central Missouri.

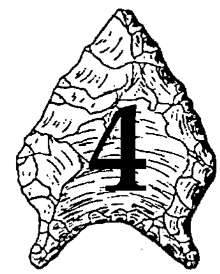
No permanent Mississippian villages have been identified in the lower Sac River valley. Shell-tempered pottery is rare, although Madison triangular points are not uncommon. A small amount of grog-tempered pottery that may be Mississippian has been recovered from a few sites (e.g., 23CE255). The cultural derivation is unclear. It possibly is of the Woodland, Plains Village, or Caddoan traditions. Early Caddoan pottery is grog tempered (Williams Plain), and at least later Caddoan components are represented in southwestern Missouri (e.g., Pangborn 1966). Shell-tempered ceramics have been commonly found in mounds assigned to the Stockton burial complex (Wood 1965), represented by relatively small earth-and-rock mounds dating to late-prehistoric times. Perttula (1989:125–127) notes the presence of Caddoan artifacts in burial mounds and rockshelters in the Sac River valley. Exotic items such as *Marginella* beads and conch/whelk shell gorgets also have been found in these mounds, indicating some movement of exotic goods from the Gulf Coast up through possibly the Caddoan heartland to the Stockton area.

The other possible Mississippian period culture represented in the Sac River valley by grog-tempered ceramics is Pomona. If K. Brown is correct in

his identifications of Pomona ceramics in Truman Reservoir, then grog- and shell-tempered pottery from many of the sites in the Sac and adjacent Pomme de Terre valleys may relate to the Plains Village tradition. Several different theories have been proposed to explain Pomona sites in the area. These mainly suggest that Pomona developed throughout western Missouri and eastern Kansas or that environmental change caused Pomona villagers to move east. In contrast, K. Brown (1984) has suggested that the western Ozarks comprised a procurement area for Pomona villages in eastern Kansas. Work parties came to the area to obtain meat and chert to transport back to their Kansas villages. For Pomona, Brown has suggested a settlement pattern minimally consisting of habitation sites, butchering stations, and hunting stations. Blakeslee and Rohn (1986) have suggested a more complex settlement system consisting of: (1) extended communities, (2) isolated habitations or farmsteads, (3) small temporary campsites, (4) large temporary campsites, (5) large limited-function sites, (6) small limited-function sites, and (7) butchering stations.

Steed-Kisker sites date primarily to A.D. 1000–1200 in the heartland area to the north (Chapman 1980:156–161). In contrast to the Pomona phase to the west, Steed-Kisker represents a full-fledged Mississippian manifestation. Steed-Kisker people produced shell-tempered pottery. The predominant type consisted of globular jars with strongly angled shoulders and flat necks that were often incised with linear and curvilinear designs. They were maize agriculturalists, although recent evidence obtained by the author of this chapter suggests somewhat of a revision of previous thinking. Based on the first flotation evidence from two Steed-Kisker sites in Clay County, it seems apparent that these Early Mississippian people continued the Woodland polycropping tradition, relying on maygrass, chenopod, little barley, sunflower, and marsh elder in addition to maize. Ample evidence has been compiled to show that these Mississippian people also relied to a great extent on hunting, trapping, fishing, and musselling. In fact, some Steed-Kisker groups may have travelled long distances hunting bison and deer. One well-known Steed-Kisker site, the Vista Shelter, is situated in St. Clair County along Weaubleau Creek, a tributary of the Osage. This site is interpreted as a hunting station, particularly for bison and deer (Wood 1968).

PREVIOUS INVESTIGATIONS AT BIG EDDY



Neal H. Lopinot

The Big Eddy site (23CE426) extends along a substantial southwest-northeast cutbank. It covers the width of the USACOE sloughing easement in this locality (Figure 4.1). Earlier studies of the cutbank and test excavations indicated a large site with one or more buried components (Schmits 1988:111–118). The extent of the site beyond the easement was not defined, but the surficial portion within the easement formerly measured 2.59 acres (10,500 m^2) as estimated by Ziegler (1994:52). We now know that the site is substantially larger, extending at least 60 m farther to the east and well to the north of the sloughing easement.

Environmental Systems Analysis, Inc. first surveyed the area in 1986 and noted chipped-stone tools, ground-stone tools, and debitage eroding from a 130-m stretch of the cutbank to a depth of 60 cm (Schmits 1988:111). A corner-notched point, tentatively identified as Late Archaic, was found on the surface of the cutbank. Schmits (1988) also reported that Aaron Brauer, a local collector, possessed Early to Middle Archaic artifacts from the site. These earlier artifacts include Rice Lobed and Searcy (Rice Lanceolate) points derived from the cutbank itself or from displaced materials at the base of the cutbank (see Schmits 1988:Figure 24). Analogous bifaces at the nearby Montgomery site, which is situated in a similar floodplain setting, occurred at about 2.4–3.2 m below surface (bs) (Collins et al. 1983).

Environmental Systems Analysis subsequently undertook testing at the site. This entailed additional examinations of the cutbank, as well as the excavation of eight 1-x-1-m units and three backhoe trenches (Figure 4.2). The eight test units were scattered along the bank and inside the site limits within the sloughing easement. The hand-excavation units varied from 80 cm to 110 cm bs in maximum depth, which in retrospect cannot have evaluated any deeply buried components, including the middle Late Archaic midden deposit. Three backhoe trenches also were excavated to a depth of 3.0 m bs, but no buried material was noted in them. The trenches were placed 10–50 m north of the cutbank.

According to Schmits (1988), the upper A horizon appeared to be no more than 20–30 cm in thickness. An underlying transitional A-B horizon, composed of a very dark grayish brown silt loam, extended downward from 20–30 cm bs at the top to 50–80 cm bs at the bottom. The underlying B horizon was described as a yellowish brown silty clay that extended to a depth of at least 110 cm bs. Cultural materials apparently were found throughout these horizons. Schmits (1988:114–117) defined an "upper component" principally at 30–60 cm bs and a "lower component" at 80–110 cm bs. He also indicated the likelihood that "an earlier, and presumably deeper component is present," based partly on Aaron Brauer's collection and partly on the fact that a flake was found at a depth of 2.0 m bs along the cutbank (Schmits 1988:117). Unfortunately, slumpage from the cutbank may have obscured the deeper deposits at the site during survey and testing, and at least two of the three deeper trenches were excavated into younger alluvial terrace fills (see Schmits 1988:Figure 23).

Surface and test-unit artifacts reflected a variety of activities and components. At least one hearth-like feature, consisting of a cluster of charcoal, burned earth, and debitage, was defined at a depth of 35 cm bs in Test Unit 8. This unit was located near the cutbank in the southwestern part of the site. In terms of chronology, the early bifaces

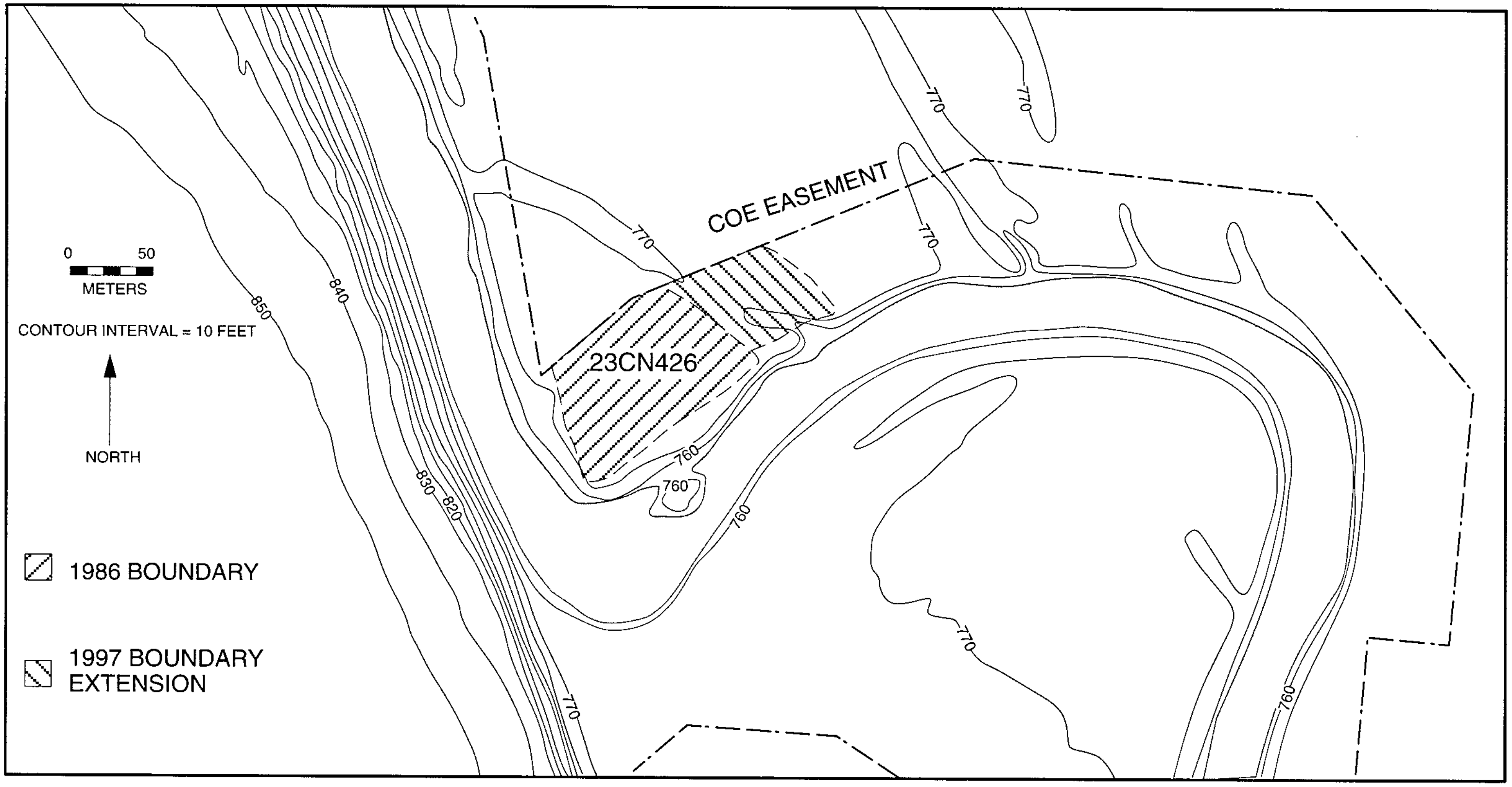


Figure 4.1. Site boundary and easement location at the Big Eddy site (the river configuration is based on a 1973 COE map, shoreline was different during the 1986 and 1997 investigations, see Figure 4.2).

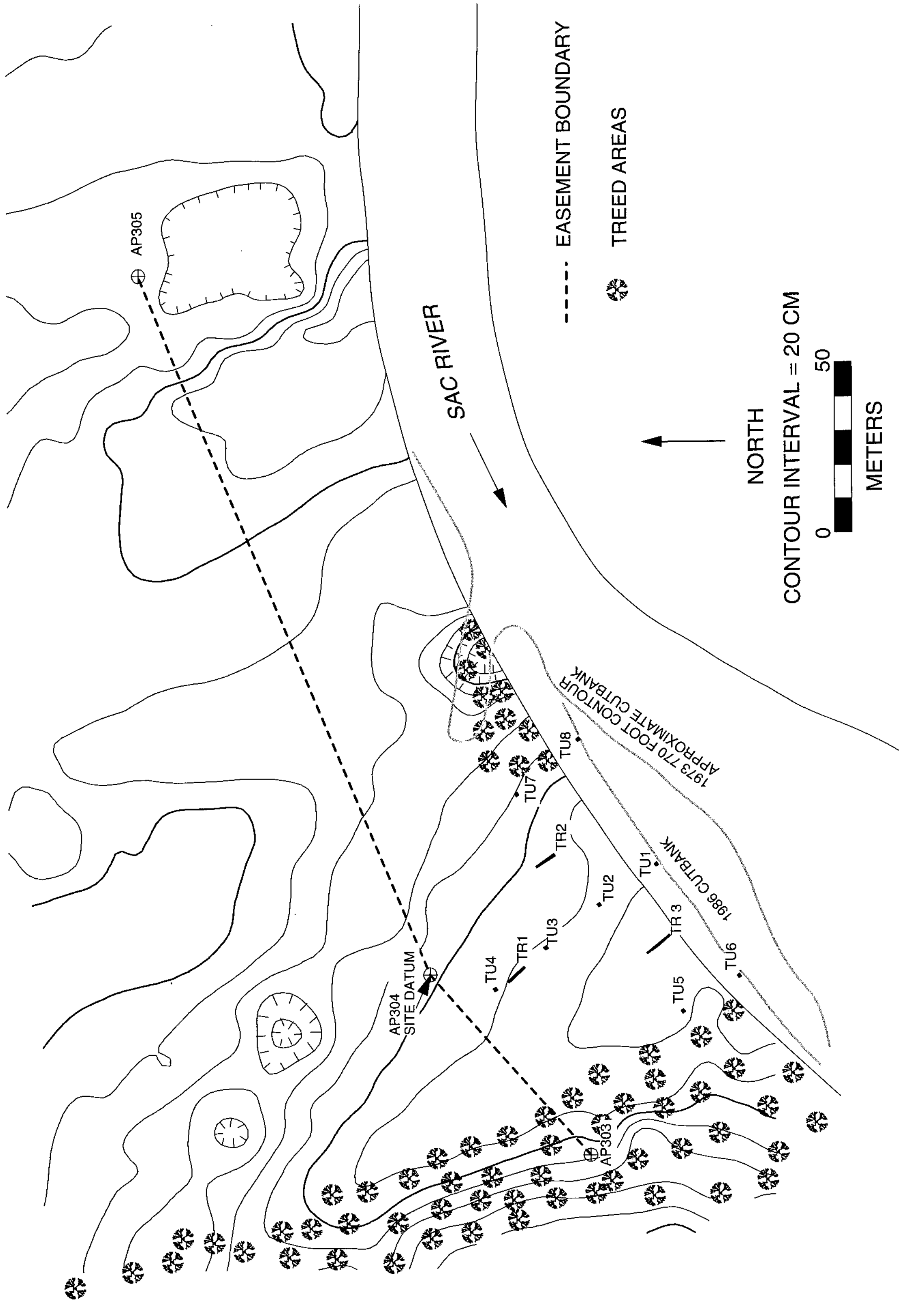


Figure 4.2. Location of 1986 Phase II excavations and previous cutbanks at the Big Eddy site.

Figure 4.3. The cutbank at 23CE426 in 1996 (view to west).

found by Brauer were of Early-Middle Archaic origin, whereas a straight-stemmed biface with a broad blade found in 1986 along the cutbank probably dates to the Late Archaic. Schmits (1988:117) also recovered several small Kings Corner Notched points with expanding bases, which he considered as terminal Archaic. No prehistoric ceramics were found. However, a piece of mussel shell, hinting at the potential preservation of faunal remains, was recovered during the excavation of one of the backhoe trenches. The site was interpreted as a seasonally utilized residential camp, at least during the Late Archaic period (Schmits 1988:134–139). Because of the potential variety of components (including multiple Archaic components, about which little was and continues to be known for the Sac River valley), the array of represented activities, the depth of the deposits, the evidence for the existence of features, and the extensive nature of cutbank erosion, Schmits (1988:1170–118) recommended that the site be considered eligible for the NRHP and that "data recovery operations be undertaken as soon as possible."

Ziegler (1994:48, 52), who conducted on-site monitoring from 1989 and undertook a photogrammetric study of the site, noted severe erosional damage along a 190-m long cutbank at the site. Hundreds of displaced artifacts (including bifaces) were on the lower bank and gravel deposits. Aerial photographs taken in 1975 and in 1990 indicated that the river had cut about 8.5 m (28 ft) into the site, meaning that about 3,683 m^2 (0.91 acres) had been lost. This is about 35% of the site within the easement, leaving only about 6,800 m^2 (1.68 acres) of the former 10,500 m^2 (2.39 acres) remaining. Flakes were exposed in the cutbank in two apparent strata, one extending from the surface to 45 cm in depth and the second approximately 210–220 cm bs. In addition, Ziegler (1994:48) saw, but left uncollected, a Graham Cave Side Notched point, two other side-notched fragments, and a Jakie Stemmed point on the lower bank or gravel. These are indicative of Early and/or Middle Archaic components.

In February 1996, Jack Ray and Jeff Yelton, research archaeologists at CAR, visited the site in preparation of the data recovery plan. The site was in a pasture, part of which had been fenced off. Erosion was noticeable along the entire cutbank (Figure 4.3). At the time of the visit, the cutbank was entirely clear of sloughed clumps of grass and piles of

earth, which apparently was not the case in 1986 and in the early 1990s (Figure 4.4; cf. Schmits 1988: Figure 23; Ziegler 1994:Figure 5.7). Numerous flakes were visible on the gravel bar at the base of the cutbank. Several flakes were also visible in the cutbank, which was over 5 m high. Spot checks along the lower portion of the cutbank revealed abundant in situ flakes at depths of 300–340 cm bs (Figure 4.4) and a possible exposed hearth (later interpreted as a natural feature resulting from a burned tree) at a depth of 340–350 cm bs. In addition, two buried A horizons were delineated in the cutbank profile (Figure 4.5). A narrow column profile revealed a complex sequence of buried surfaces. Ray (cited in Lopinot and Yelton 1996:37–39) noted:

> This site contains deeply buried archaeological deposits in an Early to Late Holocene terrace approximately 5.2 m (16.9 ft) in height. The site is situated on the right bank which is actively (and rapidly) being eroded by high-discharge outlets from Stockton Lake, as well as [by] natural floods.
>
> The terrace appears to be the equivalent of Vance Haynes' Rogers alluvium (terrace) in the neighboring Pomme de Terre River valley (Haynes 1976, 1985). The deep alluvial deposits at 23CE426 may represent a compound terrace. The lower half (horizons 3Ab1-3Bt3) appears to represent rapid vertical accretion that occurred during early Holocene times. A short hiatus in fine-sediment deposition may have occurred during the Hypsithermal Interval followed by renewed aggradation (near the end of the Hypsithermal) creating the middle-late Holocene soil horizons (Ap-2Bt2).
>
> Based on the apparent rapid aggradation of the lower portion of the T-1, there is a good possibility of delineating sealed or single component Dalton/ Early Archaic living surfaces, much like the deep early Holocene deposits at the nearby Montgomery site (Collins et al. 1983). Indeed, the alluvial deposits at 23CE426 appear to represent the same terrace unit in which early prehistoric materials were incorporated at the Montgomery site. Based on the artifact density represented in the limited profiling conducted in the 3Ab2 horizon, the Early Archaic component(s) may represent the most concentrated prehistoric deposits at the site.

A generalized profile, accompanied by descriptions of each horizon, was prepared (Figure 4.6 and Table 4.1).

In summary, the brief visit to the Big Eddy site in 1996 and previous observations indicated the likelihood that several Archaic components were present at the site. Of particular importance would be any Early Archaic component, since relatively few open-air Early Archaic sites have ever been excavated in the Midwest. Based on the presence of Kings Corner Notched points, it was assumed that at least one Woodland or terminal Archaic component was present. Testing demonstrated the existence of two sub-plow-zone components at 30-60 cm bs and 80-110 cm bs; these were tentatively identified as Woodland and Late Archaic components. Unfortunately, the hand excavations were halted well above the richest deposits at the site, and the backhoe trenches somehow missed them as well. Given the evidence available before the 1997 excavation (mainly the presence of Rice Lobed, Graham Cave Side Notched, and Jakie Stemmed points), it was believed that these rich, deeply buried deposits probably dated to Early Archaic times and possibly to Dalton times.

Figure 4.4. Exposed in situ flakes in cutbank approximately 3.2 m below surface.

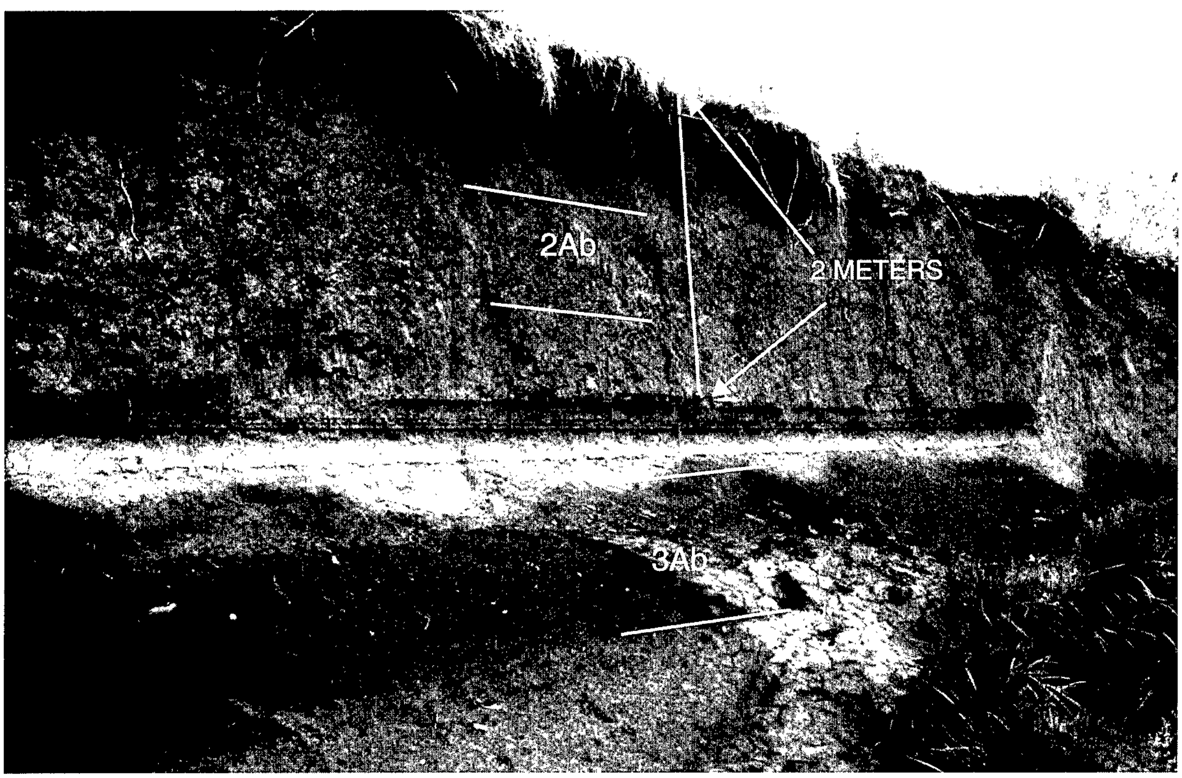


Figure 4.5. Cutbank profile on south side of site exhibiting buried A horizons.

Table 4.1. Initial Soil-Profile Description at Big Eddy.

Horizon	Depth (cm)	Description
Ap	0-28	Very dark brown (10YR 3/2) silt loam; fine granular; very friable; clear, smooth boundary.
A2	28–56	Very dark brown (10YR 3/2) silt loam; weak subangular blocky; very friable; gradual, smooth boundary.
Bt1	56–93	Dark yellowish brown (10YR 4/4) silt loam, 15% clay; moderate subangular blocky; firm; clear, smooth boundary.
2Ab	93–150	Dark brown (10YR 3/3) silt loam, 10% clay; moderate, subangular blocky; firm; clear, smooth boundary.
2Bt1	150–170	Dark yellowish brown (10YR 4/6) clayey silt loam, 20% clay; strong, subangular blocky; very firm; diffuse boundary.
2Bt2	170–223	Dark yellowish brown (10YR 4/6) clay loam, 23% clay; strong, subangular blocky; very firm; clear, smooth boundary.
3Ab1	223–303	Brown/dark brown (10YR 4/3) silt loam, 15% clay; moderate, subangular blocky; friable; diffuse boundary; charcoal flecks at ca. 240 cm; in situ flakes in lower portion, ca. 280–303 cm.
3Ab2	303–358	Brown/dark brown (10YR 4/3) silt loam, 15% clay; moderate, subangular blocky; firm; diffuse boundary; in situ flakes and burn feature in upper portion; 303–325 cm.
3bt1	358–406	Brown/dark brown (10YR 4/3) clayey silt loam, 20% clay; moderate, subangular blocky; firm; diffuse boundary.
3bt2	406–426	Brown/dark brown (10YR 4/3) clayey silt loam, 20% clay; strong, subangular blocky; firm; diffuse boundary.
3bt3	426–446+	Brown/dark brown (10YR 4/3) clayey silt loam, 22% clay; strong, subangular blocky; firm; 10–15% gray mottles; diffuse gravel lens at ca. 436 cm; 5% or less sub-angular pebbles.

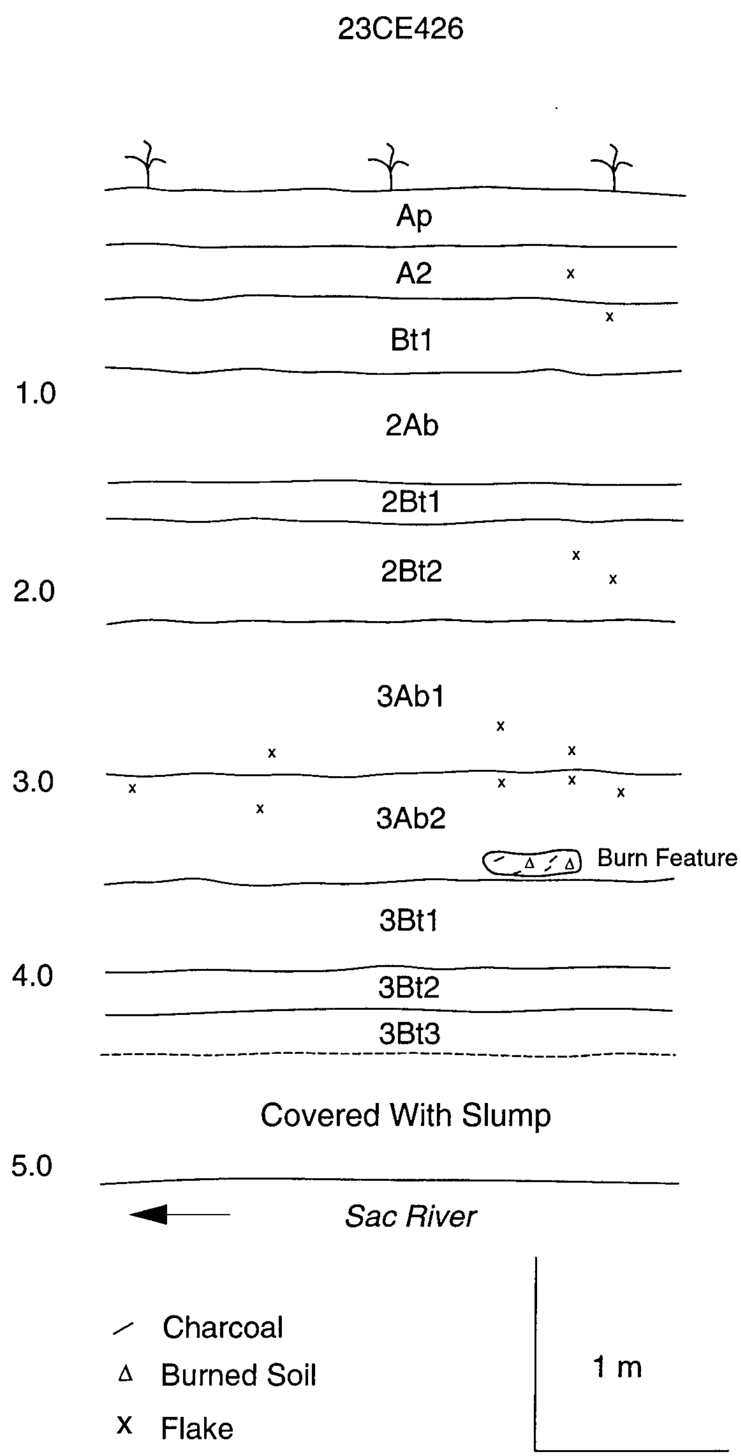


Figure 4.6. Soil profile identified in 1996 at the Big Eddy site.

RESEARCH DESIGN

Neal H. Lopinot

Basic aspects of a data recovery plan (DRP) for this project were developed by Lopinot and Yelton (1996). This plan had undergone several revisions, each time resulting in scaled-down versions of preceding ones (e.g., smaller block excavations, fewer hand excavations and more machine excavations, less screening and more shovel scraping). The DRP that was eventually developed and accepted consisted of a much reduced version of the original; however, it represented an effort to investigate all known deposits to some extent. As will become evident, the parameters established in the DRP were greatly exceeded in terms of the extent of excavations and analyses. The identification of unprecedented stratified Paleoindian deposits, the unanticipated presence of a Late Archaic midden deposit, and the complexity of the site's geoarchaeology required considerable departures from our original plans. Thanks to two extensions and supplemental monies provided by the USACOE Kansas City District, we were able to undertake additional fieldwork and some of the extra analyses. Adequate funding for the large number of radiometric assays, as well as the variety and number of different types of sedimentological and chemical analyses, attests to the USACOE's recognition of the substantial importance of the Big Eddy site.

The DRP provided general guidance on why and how to undertake specific field and laboratory methods, but its usefulness became increasingly limited as field operations progressed and unanticipated findings and problems were confronted. In hindsight, our research design was a relatively naive effort to identify problem areas for research and generate approaches that would shed new light on those research problems, principally voids in our knowledge of culture history. The apparent naivety was partly due to the limited amount of information derived from previous testing. In the absence of more information about what was present at the Big Eddy site, particularly in the deepest deposits, it was difficult or impossible to know what research problems could be examined and what problems could not. The development of a more refined DRP also would have benefitted greatly from greater knowledge about the site's geomorphic complexity.

Basic elements of our original research design focused on common domains of knowledge needed to better understand the prehistory of the region. The DRP did not offer any new experimental techniques for examination, but simply attempted to identify basic informational needs about past lifeways and cultural change. We were hopeful of obtaining data from the Big Eddy site pertaining to basic chronology, settlement patterns, and resource-procurement strategies. Such aspects of prehistory and history are predictable themes for research designs developed in the context of cultural resources management (CRM) projects. In contrast, CRM projects rarely involve the experimental use of innovative methods or techniques, owing primarily to the routinized nature of various undertakings and the relatively standardized expectations of most managers of cultural resources.

Since the 1970s, when work was initiated in the lower Sac River valley, archaeology has witnessed the rapid development of new theoretical perspectives, improvements in field and laboratory techniques (e.g., flotation), innovations in technology (e.g., accelerator mass spectrometry), and the accumulations of greater amounts and varieties of data permitting more in-depth analysis of site formation and cultural variability. Such developments make

newer excavations and reevaluations of previously excavated sites and older collections more valuable in terms of the richness of information that can be extracted. Thus, work at the Big Eddy site has benefitted greatly from a variety of technical and knowledge-based advances that have occurred during the last two decades.

As shown in Chapter 3, we know extremely little about when, why, and what people were doing throughout prehistory in this region. This is not meant to demean the continued relevance of previously collected data, particularly that obtained in the nearby lower Pomme de Terre valley, but there exist gaping holes in our understanding of prehistory in the general region. For the Sac River valley, this is due in part to: (1) the general absence of extensive excavations at sites, (2) the paucity of radiocarbon dates from good contexts in association with particular types of tools and ceramics, (3) the complete lack of systematic analyses of plant and animal remains recovered by flotation methods, (4) the absence of any prior efforts to collect paleoecological data, and (5) what archaeological data exist were generated by limited excavations at habitation sites and/or campsites in late Holocene floodplain deposits.

The following two sections contain slightly revised excerpts from the DRP for the Big Eddy site (Lopinot and Yelton 1996:39–45).

BASIC RESEARCH PROBLEMS POSED IN THE DRP

Surface collections and test excavations at the Big Eddy site indicated a light-density scatter of Late Archaic and Woodland materials. It was suspected that more than one Woodland occupation was possible. However, the early, deeply buried component(s) was considered to have the greatest significance in developing the research design for the project. It was originally thought that this deposit dated to the Early Archaic period based on previous collections (Schmits 1988; Ziegler 1994). Given that the depth of deposits approximated those at the Montgomery site, located a relatively short distance upstream from the Big Eddy site, we also considered the possibility that a Dalton component might be present, though less likely than an Early Archaic component. Despite this speculation, we were not certain of the actual age of the deeply buried component(s), since no temporally diagnostic artifacts had been found in situ and reported.

The chronology of the earliest occupations in the area is poorly known. For example, most of the research from the nearby Montgomery site depended on the recovery of exposed hafted bifaces from slumped cutbank deposits. Only one radiocarbon sample was obtained, and its relationship to the early cultural deposits remains unclear (Collins et al. 1983). Dates are available for the lower levels at Rodgers Shelter (Kay 1983; McMillan 1976a), but these do not provide any type of refined chronology for the Dalton and Early Archaic assemblages contained within them. Furthermore, some evidence (e.g., a number of hafted biface types in three to five different horizons representing a few to many millennia, the infrequency of features in some of the richest deposits, and so forth) would lead one to believe that this site was extensively bioturbated. In any regard, the number of dates from Early Archaic sites is few, and the sequence of biface styles is only grossly understood (O'Brien and Wood 1998). Every effort should be made to obtain radiocarbon samples, including the collection of larger-than-normal flotation samples for recovering sufficient carbon-based materials for dating.

With few exceptions, the Early Archaic in the western Ozarks is known only from components in caves and rockshelters. This has severely limited our view of early settlement-subsistence systems, as few open-air sites have been adequately examined. Our understanding of later Archaic sites is also biased in favor of caves and rockshelters. The Big Eddy site was an open-air settlement that was probably used for a variety of purposes, ranging from a base camp or base settlement to a specialized resource-procurement location. Because of the multiple components represented, the site should contain data pertinent to understanding settlement functions within regional settlement systems. Of course, this will depend on the recovery and analysis of lithic materials, botanical debris, and faunal remains.

Owing to the limited number of previously obtained dates in the middle and lower Sac River valley, a considerable amount of emphasis should be placed on obtaining radiocarbon samples from features or buried living surfaces. Radiometric assays are especially needed wherever good associations of carbon materials and hafted bifaces are identified. The establishment of a chronological framework is the foundation for any analysis of spatial variability and cultural change. One or a few

dates are generally insufficient to establish adequately the age(s) of a settlement, a deposit, or an artifact type. Rather, suites of dates are needed to strengthen and refine the reliability of those ages assigned to a particular phenomenon.

Analysis of lithic artifacts should focus not only on the probable functions of formal tools, but also on debitage resulting from tool production and rejuvenation. Lithic-resource procurement strategies and tool-production trajectories are not well understood for early components. The use of local vs. nonlocal or exotic lithic materials should comprise a major aspect of the research. This should require efforts to identify potential local source areas and workshops. It also requires that the researcher has considerable knowledge of regional lithic sources and geological contexts.

Biological materials from the Big Eddy site should permit interpretations of subsistence strategies and the seasonal nature of occupations for each component. If definite Woodland and Late Archaic components can be defined in the upper strata of the site, these should contain important information about wild plant utilization and perhaps food production. Mitigation will incorporate the collection of flotation samples and the analysis of botanical remains for all components. Nevertheless, researchers may wish to place the greatest emphasis on analyses favoring the early component(s), so long as ample evidence can be obtained for later components from other sites in the area. Bone preservation apparently is poor. Schmits (1988:114–115) reported a single piece of unworked shell from one of the backhoe trenches. Faunal analysis should include the cataloging and identification of what is anticipated to be a small sample of bone.

PROPOSED MITIGATION PROCEDURES FOR BIG EDDY

No additional surface survey was recommended for the Big Eddy site, with the exception of the collection of surface contour data prior to removal of the plow zone. No stripping or excavation should occur within 3 m of the cutbank in order to avoid contributing to further slumping. This will reduce the area to be investigated from about 6,800 m^2 to about 6,400 m^2. In addition, access to conduct archaeological investigations in the western part of the site was denied by the landowner. This further reduces the area by about one-third, thereby leaving roughly 4,300 m^2 for investigation.

Stage 1

The cutbank, especially the lower bank, should be thoroughly examined at the same time that topographic data are being collected. Two vertical columns spaced about 50 m apart should be cleared from the top of the cutbank to its base to fully examine and map the stratigraphy of this complex location. These profile columns should be 2–4 m in width. In addition to these two profiles, accessible lower portions of the cutbank (ca. 2.5–4.0 m below surface) should be cleared for a distance of 50–100 m. The cutbank investigations are intended to provide information for the most favorable placement of deep trenches that will be excavated after surface stripping. Systematic mapping of portions of this cutbank should be undertaken.

If the apparent hearth-like feature found in February, 1996, is still present, it should be salvaged. Similarly, an attempt should be made to excavate any other features that are defined in the cutbank. Excavators should not deeply undercut the existing bank. This means that it may be impossible to delineate feature forms in plan view before removal. Sufficient time should be budgeted for the mapping and excavation of about five features. Flotation samples should be removed from these features wherever possible.

Stage 2

After landowner permission is granted, a grader should be used to strip off the plow zone, except for the 3-m balk adjacent to the cutbank. Since previous investigations (Schmits 1988) indicate that artifacts are concentrated in the northern and northeastern parts of the site, that area should be stripped to mitigate the Woodland and Late Archaic components. Heavy equipment should be used to strip the plow zone from about 3,000–4,000 m^2. It is anticipated that this will take three days and will require the use of a front-end loader to clear the rows of dirt created by the grader. As much as possible of the backdirt should be piled within the easement to the east of the site, but not within 3 m of the cutbank. If this is not feasible, then the backdirt should be placed nearby to the northeast and outside of the easement boundary, thus requiring landowner permission. Any concentrations of artifacts in sub-plow-zone contexts should be identified and collected as specific features. Diagnostic artifacts should be piece plotted.

Excavators should anticipate no more than 50–100 features in the stripped area. Features should be flagged when uncovered and mapped as soon as possible. Since features may occur at different depths due to the apparent rapid rate of sediment accretion, the depth of each feature must be measured from a fixed datum. Each feature should be plotted and drawn in plan view. After each feature is sectioned, a profile should be drawn and photographed. Radiocarbon samples should be taken whenever possible from these contexts. Flotation samples also should be obtained from all features or internal strata within features.

Stage 3

Repeated examinations of the cutbank indicate that artifacts occur down to about 3.5 m below surface, with two major depositional horizons at about 2.0–2.2 m and 3.0–3.4 m. To facilitate the sampling of these deposits, we recommend that two backhoe trenches be excavated to a depth of 4.0-4.5 m below the original land surface, unless the water table is encountered at a higher level. These should be 25–30 m in length and begin at least 3 m away from the 3-m balk. One trench should be near the hearth noted in the western end of the cutbank, but within the area for which landowner permission has been granted. The other trench should be placed farther east wherever the greatest amounts of cultural debris are observed during cutbank cleaning. We anticipate that the excavation and mapping of these deep trenches will take approximately two days of heavy-equipment use.

These deep trenches will require a trackhoe with a minimum of a 5-foot, straight-edged bucket. OSHA regulations (29CFR1926, subpart P) must be followed during the trenching and other deep excavations. Since shoring or other protective devices would be quite expensive and would mask the profile walls, the trenches should be stepped vertically. The silt loams identified at the site are classifiable as Type B soils, which require a slope gradient of no more than 45° (1:1). A 4-m deep trench excavated with such a machine will be 1.5-m wide at the base and 7.5-m wide across the top with two 1.5-m high steps at 1.5-m intervals.

Stage 4

Given that cultural materials are scattered throughout the profile to about 3.5 m, a single columnar control unit measuring 1 x 1 m should be excavated in 10-cm levels from the base of the plow zone down to (but not into) the deepest cultural horizon. This will entail the excavation of about 25 levels to about 2.8 m below surface. The placement of such a unit or series of vertically continuous units should be based on the trench profiles and should take advantage of the richest deposits. In the absence of shoring, such a unit must be stepped; as such, the location of the unit on each step could vary to sample the most productive deposits. One wall of the control unit(s) should be mapped and a columnar series of 10-liter flotation samples should be collected from the mapped wall(s) at 10-cm intervals. Thus, about 25 samples will be removed for flotation and soil analyses.

Stage 5

Based on stratigraphic and artifact-concentration data from the exploratory trenches and the cutbank profiling, the depth for intermediate stripping activities will be selected. As the result of work by Ziegler (1994) and CAR, it seems most likely that deposits at about 2.0–2.2 m represent a Middle to early Late Archaic horizon containing the greatest potential for defining features, locating diagnostic artifacts, and collecting subsistence remains. To facilitate excavation, a trackhoe will be used for two days to remove any (additional) overburden to a depth of about 2.0 m below surface, or to the level at which the richest "intervening" cultural deposits begin. A block area of about 400–500 m^2 shall be opened by the trackhoe to this approximate depth. Once attained, additional careful stripping of the area in 3–5-cm levels shall be undertaken in order to locate features and diagnostic tools, all of which shall be located vertically and horizontally using an established datum. Features or portions thereof that are exposed within the block area during stripping should be excavated fully, following profiling and removal of flotation samples.

Stage 6

In order to investigate portions of the lower component(s) of the site beginning about 2.8 m, two block areas measuring 5 x 5 m will be opened with a trackhoe to that depth. During a two-day period, the trackhoe also will remove additional overburden around each block to provide stepping. Within each of the block areas, a 2-x-2-m unit will be hand-

excavated in 10-cm levels to a depth of 3.5 m. Each level in one 1-x-1-m unit in a corner of each 2-x-2-m unit will be screened, whereas levels in the other quadrants will be shovel skimmed. Any identified features should be excavated fully, including profiling and removal of flotation samples. In addition, at least two columnar series of 10-liter flotation samples will be removed at 10-cm intervals from two profiled walls in each block unit. For two blocks excavated in seven levels, this would yield a total of 28 samples. Prior to processing, subsamples for palynological, soils chemistry, and sedimentological analyses should be removed from all flotation samples.

After completion of these hand excavations and sample collections, the trackhoe shall be used during two days to strip remaining portions of the 5-x-5-m block areas down to about 4.0–4.3 m. The investigators shall be particularly careful during the stripping at about 3.2–3.4 m below surface. All encountered features shall be properly excavated and any observed diagnostic artifacts shall be mapped and collected. The final step will be backfilling, which is estimated to take a bulldozer eight days to complete because of the extensive size of the stepped backhoe trenches and deep block units, in addition to replacement of the original plow zone matrix.

ESTABLISHING DEPOSITIONAL INTEGRITY

The above synoptic field plan was generally followed. However, the relative importance of our findings during the course of the fieldwork required greater attention to defining depositional integrity, particularly within the deepest deposits. Of course, this is always a major concern of any archaeologist, but the finding of stratified Paleoindian and possible pre-Clovis deposits necessitated placement of greater emphasis on collecting information about the quality of depositional integrity. Certain types of analyses (e.g., sediment and chemical analysis) took on added significance, while some initially unplanned forms of data gathering were implemented.

Excavations at the Big Eddy site resulted in the definition of relatively discrete living surfaces within portions of some alluvial fills. In other portions of the site, there are less visually obvious, but generally continuous, vertical accumulations of alluvium with diffuse cultural additions. It is assumed that the various layers of artifacts within individual alluvial-fill levels represent relatively discrete episodes of prehistoric activities. Some of these episodes of site use were more intense than others, but much of the known prehistoric sequence in the region appears to be represented at the Big Eddy site. The occurrence, excavation, dating, and analysis of archaeological and paleoenvironmental residues within such discrete deposits or levels are essential to building cultural chronologies and evaluating changes in cultural adaptation and the natural environment. The importance of the Big Eddy site in these regards is quite substantial.

Although it was apparent that the stratigraphic integrity of some of the deposits at the site is excellent, this does not preclude postdepositional movements of artifacts, both vertically and horizontally. Studies of site-formation processes in the Old World and New World have documented the dynamic nature of soils, even those that are buried rapidly and/or deeply (e.g., Schiffer 1987; Villa 1982). It seems logical to assume that the effects of postdepositional activities should decrease with increased depth of burial, but the soils are still not static once they have reached a particular depth. As such, depositional integrity is a relative term; that is, integrity is never perfect, but it ranges from nearly so to none at all.

Artifacts can be translocated laterally and vertically as a result of many different factors. Postdepositional trampling, excavations by later occupants, recycling of larger artifacts, animal burrowing (e.g., by rodents, worms, or crayfish), root actions and tree falls, frost heaving, and various forms of erosion represent some of the factors that can play havoc on archaeological deposits and materials (Schiffer 1987; Stein 1983; Wood and Johnson 1978). Artifacts and deposits also are altered by subsequent microbiological and chemical activities.

In the past, the integrity of deposits at many sites has not been adequately addressed, and certain data or ideas about the integrity of deposits were ultimately proved incorrect. In recent years archaeologists have gained a greater awareness of site-formation processes and learned to discriminate their effects through experimental and ethnoarchaeological investigations. Most archaeologists now commonly recognize the need for the

assistance of a geoarchaeologist in evaluating the conditions of landform development and are taking increasing advantage of old and new technologies directly applicable to measuring formation processes.

As such, it is incumbent that the stratigraphic integrity of the Big Eddy site is investigated by various available means. This will permit a better understanding of the relative homogeneity or heterogeneity of various layers. The typical exigencies of contract archaeology did not permit detailed microstratigraphic excavations at the Big Eddy site in 1997. This, however, should not detract from the wealth of information that has been extracted from the site to date. Furthermore, despite the coarse means of excavation, there is much that can be learned about formation processes at the site, and some sets of collected data are directly relevant to these issues. These include refit studies, measurements of the strike and dip of in situ artifacts, analysis of microdebitage distribution relative to larger lithic debris, and documentation of evidence indicative of fluvial transport.

FIELD AND LABORATORY METHODS

6

Jack H. Ray and Neal H. Lopinot

This chapter describes the methods used in the field to investigate the archaeological deposits at the Big Eddy site, as well as most of the laboratory methods used to process recovered materials. Field and laboratory investigations were designed to address relevant research problems outlined in the research design (see Chapter 5). Field and laboratory methods specific to certain analyses (such as geomorphology) are described in later chapters.

FIELD METHODS

Preliminary work at the site, conducted in late May 1997, involved the construction of a 20-cm-interval contour map of the site (Figure 6.1), the establishment of several datum stations, and detailed examinations of the cutbank. Due to the presence of large slump blocks, only isolated segments of the lower portions of the cutbank could be cleared and examined. Initial sediment coring was also attempted in late May but was postponed due to equipment failure.

Excavations at the Big Eddy site were undertaken from June 4 to August 22, 1997. Fieldwork in July and August was demanding due to very hot and humid weather; however, periodic thunderstorms and plastic cover kept the soil in relatively good working condition. The fieldwork lasted longer than expected due to unanticipated and unprecedented discoveries. Specifically, the in-field scope of work was amended twice: (1) to search for in situ evidence of Early Paleoindian use of the site, and (2) to investigate potential pre-Clovis deposits.

All excavations were restricted to those portions of the site within the sloughing easement (Figure 6.1). The only work outside the easement consisted of small-bore sediment coring to trace subsurface geomorphological features (see Figure 7.1). All excavation work was conducted at a minimum distance of 5 m from the summer 1997 bank line to avoid contributing to further cutbank slumpage.

Due to the complex, thickly stratified nature of the site, archaeological investigations were conducted in several stages. The first stage of excavation involved the stripping of the plow zone from an area of approximately 3,259 m^2. (Figure 6.1). All diagnostic artifacts encountered during the stripping were piece plotted with a SOKKIA SET5A Electronic Total Station (ETS). Plow-zone removal was accomplished with a road grader, and a front-end loader was used to clear rows of dirt created by the grader. The road grader produced a smooth surface for inspection of features (Figure 6.2). All potential features were flagged, plotted, drawn in plan view and profile, and photographed. Each feature was half-sectioned and up to 10 liters of unscreened fill was removed from the profile as a flotation sample. If the feature contained less than 10 liters of fill, the entire feature was collected as the flotation sample. If the feature contained more than 10 liters, the remaining half was excavated and screened through 0.64-cm (0.25 in) hardware cloth.

The second phase of heavy-machinery work involved the excavation of two large trenches across the north side of the site (Figure 6.1). A large Komatsu trackhoe with a 1.2-m-wide bucket was used for the deep trenching (Figure 6.3). Trench 1 was placed across the crest of the terrace on the west side of the site near the easement boundary. It measured approximately 28 m in length and covered 224 m^2. The second trench was placed across a swale or overbank channel scar on the central portion of the site. Trench 2 measured about 20 m in

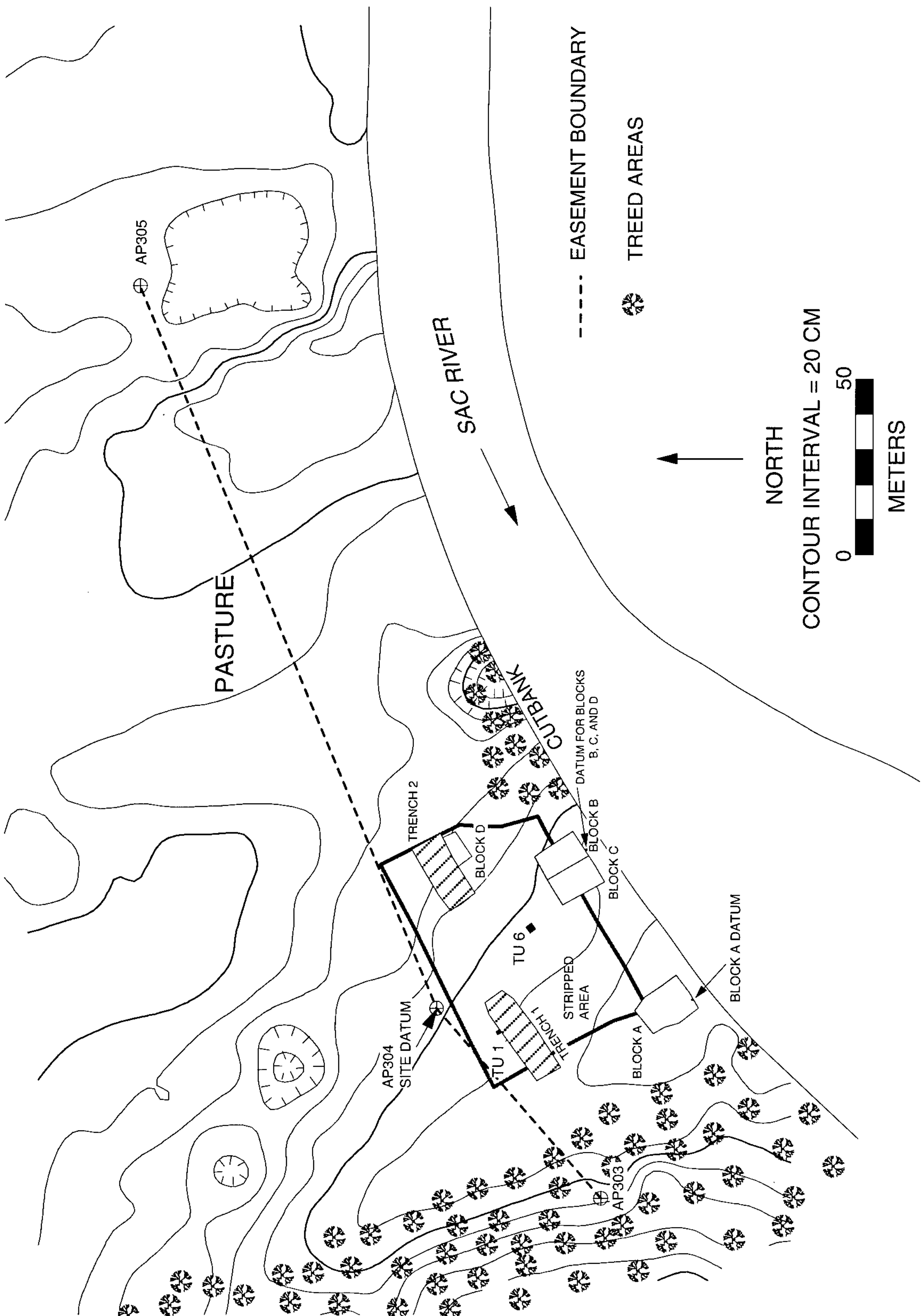


Figure 6.1. Plan view of 1997 Big Eddy excavations.

Figure 6.2. Completed stripped (plow zone) surface approximately 47 m north-south x 70 m east-west (looking north-east).

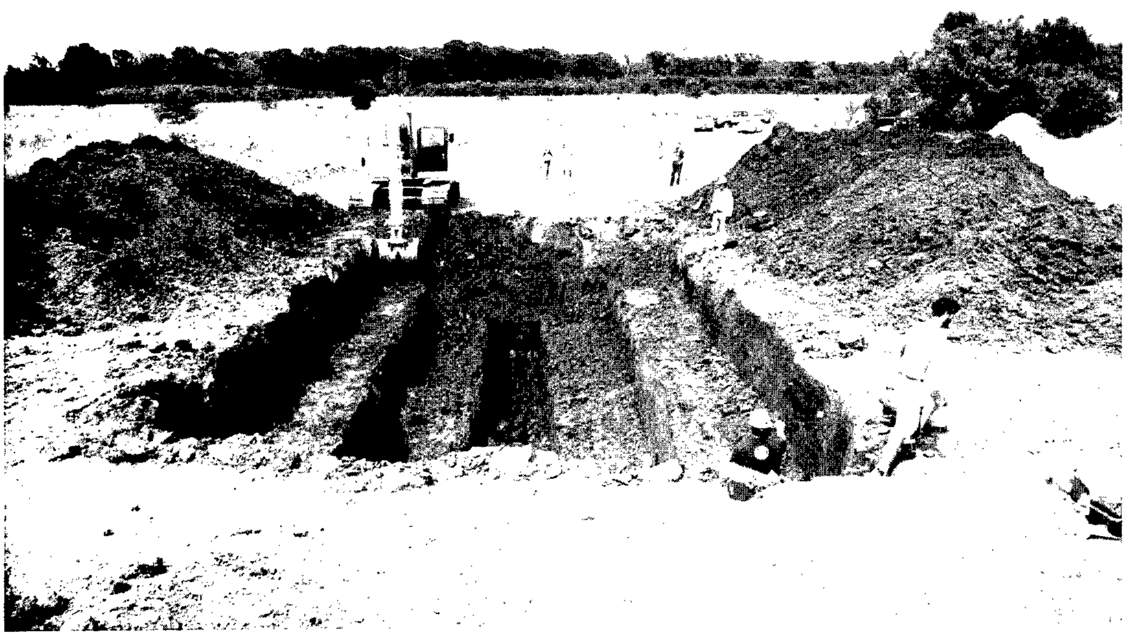


Figure 6.3. Trackhoe excavation of Trench 1.

length and covered 183 m^2. Both trenches had a maximum center depth of about 4.5–4.8 m. According to OSHA regulations (29CRF1926, subpart P), the trenches were stepped vertically at a slope gradient of approximately 45° (1:1), leaving two benches, each measuring 1.5 m in height and 1.5 m in width. Although the test trenches were excavated relatively quickly, each bucket scrape and the resulting backfill were monitored for features and/or diagnostic artifacts. After the trench excavations were completed, the south walls of Trenches 1 and 2 were shovel scraped for evidence of additional cultural features and artifacts.

The final phase of heavy-machinery work consisted of opening four large excavation blocks. The large trackhoe was also used for this operation. For these excavations, the bucket teeth were covered with a straight-edged guard for smooth scraping (Figure 6.4). Finer control was used in the excavation of these blocks; individual scrapes averaged approximately 5–10 cm in thickness. Each scrape and bucket load was carefully monitored for features and diagnostic artifacts. At certain levels, machine scraping was stopped and shovel skimming was conducted where potential features and/or artifact concentrations were noted (Figure 6.5). All designated features were mapped and fully excavated before machine scraping resumed. Like the trenches, each block excavation was stepped vertically at 1.5-m intervals. Block A was eventually machine excavated to a depth of approximately 2.3–2.6 m bs, whereas Blocks B-D were machine excavated to depths of 2.5–3.0 m bs. At the surface, Block A encompassed 167 m^2, Blocks B and C covered 135 m^2 each, and Block D covered an area of about 40 m^2 (Figure 6.1). Later in the project, the trackhoe was also used to excavate a 1.7-m-wide test trench in the east half of Block B to the graveliferous substrate underlying the early Rodgers Shelter submember (see Chapter 7) to a depth of 4.9–5.0 m below surface.

Hand excavation of 37 units was conducted following completion of heavy-machinery work (Figures 6.6–6.7). All test units were located in Blocks A-D, except for TU 1 located on the north side of Trench 1 and TU 6 located near the center of the stripped area (Figure 6.1). These units measured 1 x 1 m, 1 x 2 m, and 2 x 2 m in size, and they had a depth range of 10–180 cm. One off-set columnal control unit measuring 1 x 1 m was excavated and screened (0.64-cm [0.25 in] mesh) in 10-cm levels from the base of the plow zone to a depth of 3.2 m. Segments of this control column were located in Test Units 1–4. At the completion of the control column, 2-x-2-m grids were established on the floors of each block and a series of 2-x-2-m units were excavated. Most units were dug in 10-cm levels; however, some units in the oldest and deepest deposits were dug in 5-cm levels for greater stratigraphic control. All or a sample of Test Units 1–10 were screened, whereas the remaining 27 units were carefully shovel skimmed. Each diagnostic artifact and cultural feature was plotted using the ETS, whereas nondiagnostic tools were measured vertically and horizontally by tape and line level to the nearest centimeter. All artifacts collected during the field investigations were bagged by excavation unit, depth, and level; feature number; or other pertinent provenience information. Completed hand excavations in each block comprised the following areas and volumes: Block A, 11 m^2, 5 m^3; Block B, 36 m^2, 24.5 m^3; Block C, 34 m^2, 23.2 m^3; and Block D, 14 m^2, 3.5 m^3.

In addition to the controlled excavations in the test units, the exposed cutbank bounding the south side of the site (see Figure 4.5) was continually monitored during the project, especially after power-generation releases from Stockton Dam. The eroded cutbank measures approximately 5.5 m in height and 100 m in length along the west and central portions of the site. This monitoring resulted in the recovery of in situ and displaced artifacts, cultural features, and radiometric samples.

A permanent site datum (Station 1) was established on Corps easement boundary marker AP-304 located on the north side of the Big Eddy site (Figure 6.1). This datum is 235.93 m (774.05 ft) above mean sea level (amsl). All diagnostic artifacts and features identified on the stripped surface were piece plotted in relation to Station 1. In addition to the permanent site datum, two local elevation datums were used for the block excavations. All depth measurements taken in the vicinity of Block A on the west side of the site are in relation to a datum established at the surface on the south side of TU 2 (236.37 m amsl). All measurements taken in Blocks B-D on the central portion of the site relate to a surface datum established on the south side of TU 3 (236.19 m amsl). Thus, all references to depths below surface (bs) in or near Block A and Blocks B-D are in relation to these two block datums (Figure 6.1).

Numerous specialized samples were extracted during the controlled excavations for laboratory

Figure 6.4. Trackhoe scraping in Block B at approximately 250 cm below surface.

Figure 6.5. Shovel skimming in Block B at approximately 250 cm below surface.

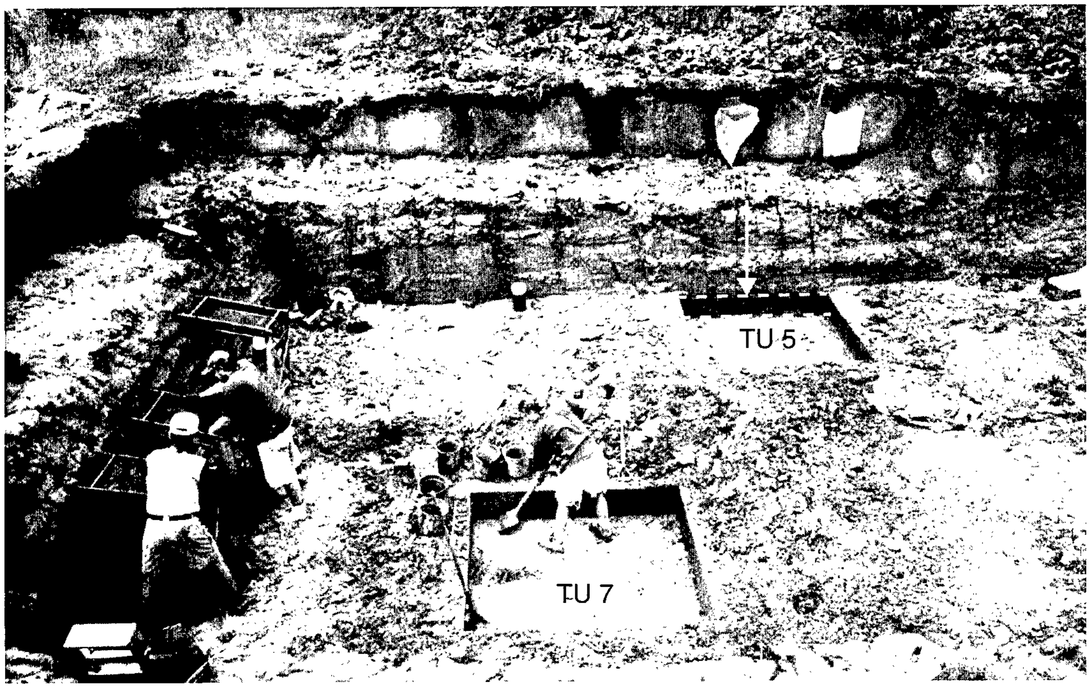


Figure 6.6. Excavation of 2-x-2-m test units in Block A at 230–260 cm below surface looking west (note midden deposit in west wall of TU 5).

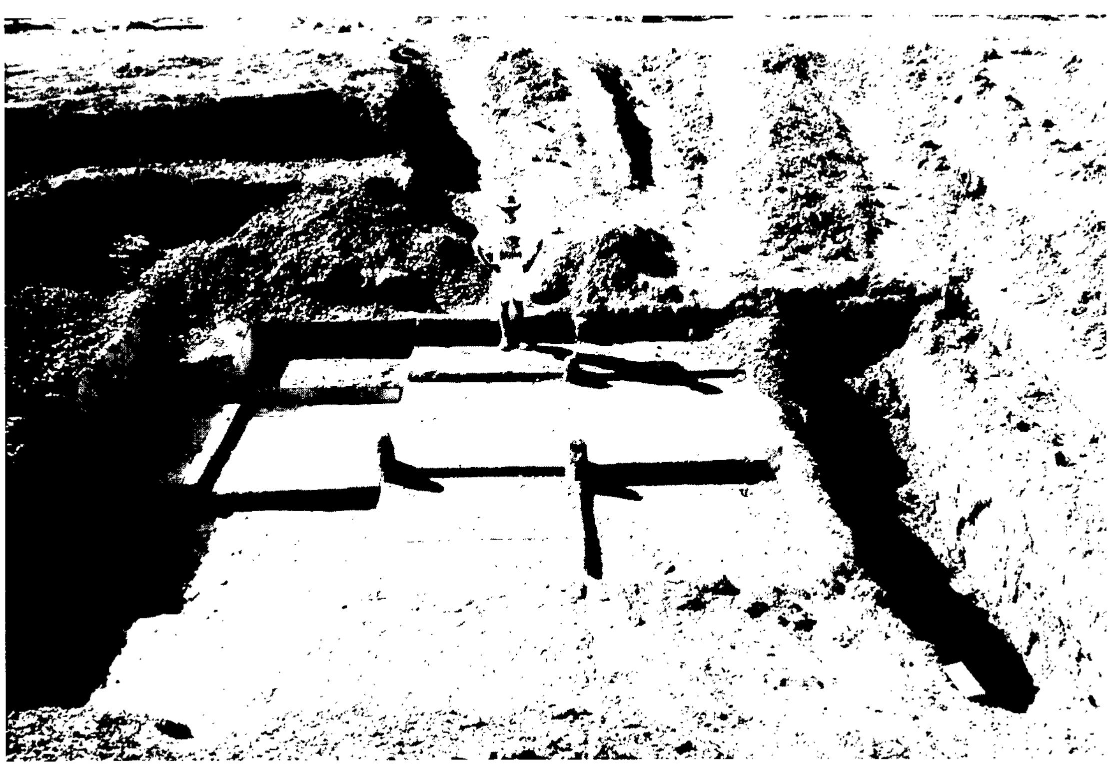


Figure 6.7. Excavation of 1-x-2-m and 2-x-2-m units in Blocks B and C at 320–360 cm below surface (note test trench to gravel substrate at 490 cm on east side of Block B).

analyses. A total of 110 flotation samples was collected from features and column profiles in various test units and blocks. Flotation samples from Archaic deposits were collected in 10-cm intervals, whereas samples from Paleoindian levels were collected in 5-cm intervals. These involved the removal of blocks of earth measuring 25 x 25 x 10 cm and 50 x 25 x 5 cm. Full flotation samples (about 10 liters when measured in the field) were collected from most locations; however, a few small features yielded samples that were less than 10 liters.

Over 175 soil samples (250–500 ml) were collected for stable carbon isotope, soil chemistry, and sedimentological analyses. These were taken at various depths from the walls of Blocks A-C, from a continuous profile on the cutbank, and from continuous columns (at 10-cm intervals) in Block B (2–400 cm bs) and Block A (2–272 cm bs). Seventy-four soil samples (400–500 ml each) from the continuous column in Block B (vicinity of TU 3 and TU 4) were divided into three subsamples: 10 g for stable carbon isotope analysis, 75 g for clay mineralogy analysis, and the remainder for particle-size and chemical analyses.

Fifty-two samples of charred wood, nut shell, and other carbonized material were collected during the excavations for study and possible radiometric assaying. Most were recovered from Paleoindian and pre-Paleoindian levels; however, several samples were collected from Archaic, Woodland, and Mississippian deposits. The samples ranged from small, fragmentary pieces for accelerated mass spectrometry (AMS) to larger aggregates of charred materials producing more than 1 g of final carbon for standard or small-sample treatment. In addition to the AMS and standard radiocarbon samples, eight bulk carbon samples (10 liters each) were collected from the 2Ab, 3Ab, and 3Bt1 horizons.

The final hand-collected samples consisted of 18 pollen samples (≈100 ml) from late Pleistocene to early Holocene horizons, extending from 270 cm bs to 355 cm bs and three thin-section samples from the 3Ab horizon. In addition, nine 8–10-g soil samples were obtained for phytolith analysis. These were removed from a set of flotation samples obtained from the late Pleistocene–early Holocene horizons (Block B, east wall), extending from 270 cm bs to 350 cm bs.

Geomorphic investigations at the site were rather extensive, and the results of this work are presented in Chapter 7. A total of 19 continuous sediment cores (5 cm [2 in] in diameter) were extracted along east-west and north-south transects across the site (Figure 7.1). These were obtained using a Giddings coring rig (Figure 6.8) and subsequently analyzed in Topeka, Kansas, and Sante Fe, New Mexico. At least one set of sediment and soil chemistry samples was obtained from a core extracted in the vicinity of Blocks B-C.

As stipulated in the project Scope of Work, all artifacts and field samples collected during the present investigations were to be delivered to the landowner, Nina Howard. Due to the unprecedented discoveries at the Big Eddy site, however, Mrs. Howard donated all materials to Southwest Missouri State University (Springfield) with permanent curation of the collections at the Center for Archaeological Research.

LABORATORY PROCEDURES AND ANALYTICAL METHODS

At the completion of the fieldwork, all artifacts and soil samples were returned to the CAR laboratory for processing. Except for some Paleoindian tools safeguarded for future residue analysis, materials were gently washed by hand in tap water and air dried. The collections were then sorted into material types (e.g., chipped stone, other lithics, ceramics, faunal remains, and plant remains) and catalogued according to provenience. The methods used in the analysis of the various material types are discussed below.

Chipped-Stone Analysis

The chipped-stone artifacts from the Big Eddy site were subjected to several qualitative and quantitative analyses that focused on flake- and biface-production trajectories. The chipped-stone assemblage was divided into debitage and tool categories and classified as to artifact type according to the typology presented below. All flake debitage measuring ≥1 cm^2 and all tools were subsequently analyzed as to raw-material type, cortex type, and thermal alteration. Debitage measuring <1 cm^2 in size was designated microflakes and considered too small for accurate identifications of raw material, cortex type, and heat treatment. Counts only were recorded for microdebitage.

A refit analysis was conducted on selected Paleoindian materials by Kary Stackelbeck (1998). This involved an analysis of the entire Early-Mid-

Figure 6.8. Extraction of sediment core with Giddings rig between Blocks B and D.

dle Paleoindian chipped-stone assemblage, and the examination of a sample of the massive Late Paleoindian collection. The Late Paleoindian refit sample contained all tools from the 3Ab horizon and the debitage and tools from all knapping features.

Core Debitage

Tested Cobble. Cobble with one or two striking platforms and a limited number of flakes (generally three or less) removed to test raw-material quality.

Working Core. Cobble with one or more striking platforms, cortex removal, and evidence of primary flake removal from at least one shaped flaking face; usually more than 5 cm in size.

Exhausted Cores. Cobble with most or all of the cortex removed, one or more striking platforms, and evidence of primary-flake production from two or more flake faces; usually less than 5 cm in size; typically too small to handle effectively while knapping.

Core Fragments. Broken fragments of cores with one or more platforms or some other evidence of flake production.

Flake Debitage

Primary Flake. Flake with more than 50% of the dorsal surface covered by cortex; exhibits a high-angle striking platform; represents initial decortication.

Secondary Flake. Flake with less than 50% of the dorsal surface covered by cortex; high-angle striking platform; represents secondary decortication.

Tertiary Flake. Flake with no cortex on dorsal surface or platform; high-angle striking platform; represents reduction of decorticated core.

Biface Flake. By-product of biface manufacture; flake with a dorsal surface partially or entirely covered by negative flake scars and retains a portion of the faceted biface edge as the platform; exhibits a low-angle striking platform.

Flake Fragment. A broken flake that lacks a striking platform and cannot be assigned to a specific category.

Informal Tools

Utilized Flake. A flake of any class that has evidence of utilization as a tool but has not been intentionally modified (flaked) to perform a specific task; use wear may be on one or more sides or ends.

Formal Tools

Side Scraper. Uniface exhibiting primary flaking on dorsal surface of flake blank and secondary flaking primarily along the lateral edges; no apparent provision for haft element.

End Scraper. Uniface exhibiting primary flaking on dorsal surface of flake blank and secondary flaking primarily along the distal end; provision for haft element on proximal end.

Unspecified Scraper. Unclassifiable uniface fragment.

Primary Biface. Shaping consists only of primary flaking (predominantly hard hammer) in a random or systematic pattern; biface edge is sinuous and biface cross-section is thick and irregular; usually retains a portion of cortex; usually represents an unfinished tool (e.g., aborted preform or early-stage production failure).

Secondary Biface. Shaping consists of primary and secondary flaking (hard and soft hammer); most or all of cortex has been removed; flaking is more systematic; biface edges are less sinuous and biface cross-section is relatively thin and lenticular; represents a late-stage production failure or preform.

Tertiary Biface. Shaping consists of secondary and tertiary flaking (soft hammer and pressure); cortex is absent and flaking is systematic; biface edges are straight and cross-section is thin; usually represents an unidentifiable finished-tool fragment (e.g., projectile point/knife midsection or distal end).

Projectile Point/Knife. Shaping usually consists of primary, secondary, and tertiary flaking (hard- and soft-hammer percussion and pressure flaking); systematic flaking and removal of cortical surfaces; generally thin lenticular cross-section; longitudinally asymmetrical with a haft element at proximal end and pointed at distal end.

Drill. Biface exhibiting a long, narrow, bitted distal end and provision for hafting on proximal end.

Graver. Unifacial flake exhibiting localized retouch forming a short, acute projection for engraving or incising.

Adze. Biface with primary and secondary flaking; asymmetrical triangular shape with bit (broad) end usually striated and polished from use.

Axe. Thick biface with one or two symmetrical convex bits and constricted midportion for hafting.

Additional attribute observations were made on bifacial tools recovered from Paleoindian and Early Archaic horizons. On broken tools these observations were break type (e.g., transverse, diagonal, and overshot), fragment type (e.g., production failure, heat failure, and use failure), and whether the bifaces were associated with other refit fragments and/or individual debitage piles (i.e., knapping features). Whole bifacial tools were weighed and measured by length, width, and thickness.

Artifacts collected from knapping features in Blocks B-D were subjected to specialized analyses. In addition to identifications of flake type, chert type, cortex type, and thermal alteration, feature debitage was separated into groups representing the reduction of individual or distinct cobbles (if possible) and subsequently size graded according to the scale in Figure 6.9. Based on the flake types and size grades represented in the feature debitage, each feature cobble was classified as to one or more biface-reduction stages (see below). In general, the four biface-reduction stages represent initial decortication and primary flaking, biface thinning and secondary flaking, final biface thinning and shaping, and tool rejuvenation/resharpening. Stages 1–3 of the biface-reduction trajectory approximate Stages 3–5 of Callahan's reduction model (Callahan 1979:9–11). Callahan's Stage 1 (raw-material procurement) is not considered part of the reduction sequence here, and his Stage 2 (initial edging) is included in our initial-decortication stage. Callahan's model has no provision for biface maintenance and recycling (our Stage 4).

Detachment Techniques

Hard-Hammer Percussion (Primary Flaking). Refers to the use of a hammerstone as a percussor. Flakes detached by hard-hammer percussion are relatively thick and large with high platform an-

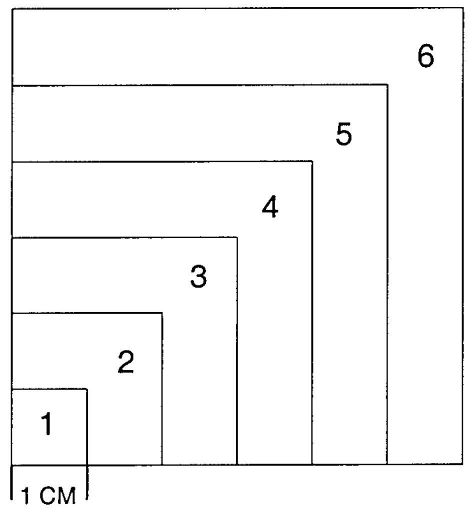


Figure 6.9. Feature debitage size grades.

gles; large, protrusive bulbs of percussion; and a cone of percussion.

Soft-Hammer Percussion (Secondary Flaking). Refers to the use of an antler, a piece of wood, or other soft implement as a percussor. This technique produces a thin flake with a low striking platform, a diffuse bulb of percussion, no cone of percussion, and a lip-like protrusion on the ventral edge of the platform.

Pressure Flaking (Tertiary Flaking). Refers to the use of manual pressure by holding the objective tool on a pad or cushion and pressing off flakes with a pressure tool such as a bone, wood, tooth, or antler tine.

Reduction Techniques

Cobble-Blank Reduction. Refers to the reduction of a cobble or nodule directly into an intended tool. The exterior portions of the cobble are generally discarded as flake debitage while the center or core of the cobble is worked into tool form.

Flake-Blank Reduction. Refers to the reduction of a cobble or nodule into a series of large or small flakes that may be used directly as tools or further reduced into bifacial form. It is a two-staged reduction process in which flakes struck from the cobble (which becomes a core) are the objective pieces that are subsequently manufactured into tools.

Biface-Reduction Stages: Cobble-Blank Trajectory

Stage 1 (Early Reduction). Represents initial testing and decortication of raw-material blanks by primary flaking (may end with blank rejection if flawed material); complete flakes are predominantly primary and secondary flakes; size grades are generally ≥ 4 cm^2; rejected objective pieces result in primary bifaces (or fragments) measuring about 1.8 cm or greater in thickness.

Stage 2 (Middle Reduction). Represents biface thinning after successful decortication by secondary flaking; complete flakes include rather comparable numbers of secondary and biface flakes (few if any primary flakes); size grades are generally 2–3 cm^2; failed objective pieces result in secondary-biface fragments measuring approximately 0.6 cm to 1.9 cm in thickness.

Stage 3 (Late Reduction). Represents final biface thinning and shaping after successful biface reduction via secondary and tertiary flaking; complete flakes include predominantly biface flakes (no primary and few secondary flakes); size grades are generally ≤ 2 cm^2; completed objective pieces result in tertiary-biface fragments measuring about 0.5 cm to 0.7 cm in thickness.

Stage 4 (Post Reduction). Represents finished tool maintenance via edge rejuvenation/resharp-

ening, repair of broken tips, and recycling of broken tools; predominantly pressure (tertiary) flaking with possible fine soft-hammer work; complete flakes are entirely biface flakes; size grades are ≤2 cm^2; failed objective piece results in tertiary bifaces and/or (rejected) projectile points/knives.

Other Lithics

This assemblage consists of ground-stone artifacts (e.g., abraders, pitted stones, and hammerstones) and other artifacts such as fire-cracked rock, pigment rock (i.e., hematite and limonite), chert shatter, and unmodified rocks (manuports). Shatter is excluded from the chipped-stone assemblage because angular fragments could be a product of activities other than knapping. Shatter refers to indistinct angular fragments of chert that lack knapping attributes such as a striking platform, bulb of percussion, and ripple marks. Shatter may be a result of breakage along incipient fracture plane(s) during hard- or soft-hammer percussion; however, it may also include heat shatter (fire-cracked rock) and shatter from disintegrating chert hammerstones. Other lithics were analyzed as to artifact type, raw-material type, cortex type, and thermal alteration.

Ceramics and Faunal Remains

Very few ceramics and faunal remains were recovered from the Big Eddy site. Ceramics were gently washed by hand and analyzed as to surface treatment and temper type. They are described in Chapter 8. Faunal remains consisted of a small, very poorly preserved sample of bone fragments. These were submitted to Bonnie W. Styles, Illinois State museum, for analysis. The results of this analysis are presented in Appendix 2.

Plant Remains

All plant materials collected by hand in the field and as a result of flotation have been analyzed (see Chapter 10 for flotation procedures). An abundance of plant remains is represented in some of the samples, but unfortunately little occurs in samples from the Early/Middle Paleoindian, Late Paleoindian, and Early Archaic levels. All materials designated for AMS and standard radiocarbon analysis also were minimally weighed and analyzed prior to submission to the University of Arizona, Tucson, or to Beta Analytic, Inc., Coral Gables, Florida.

Pollen Analysis

A series of 18 samples were submitted for pollen analysis to Dr. Eric Grimm, Illinois State Museum. This series was obtained from the east wall of Block B (Column 3), extending from 270 cm bs to 355 cm bs. It includes samples from the early Early Archaic, Late Paleoindian, and Early/Middle Paleoindian deposits. The samples were given extended hydrofluric treatments and screening to remove silicaceous material. Grimm (email message dated November 3, 1997) reported:

> Except for a few very poorly preserved scraps, there is no pollen. Nothing was identifiable except for one Pinaceae bladder. Thus, I think the potential for meaningful pollen analysis is very low. Possibly more pollen could be obtained by heavy-liquid flotation from very large samples, but because of the very poor preservation and undoubted differential preservation, I would place little value on counts obtained in this fashion.
>
> Such disappointing findings should not, however, be regarded as endemic to the entire site until proven otherwise. Thus, additional palynological work should be undertaken on samples obtained elsewhere at the site.

Phytolith Analysis

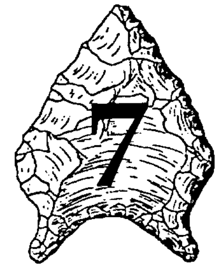
The samples collected for phytolith analysis were submitted to Dr. Glen Fredlund, University of Wisconsin, Milwaukee. The analysis of these samples has been a gratis undertaking, and results are still unavailable. However, the following message was received from Fredlund (email message dated June 11, 1998):

> The goal of this analysis was to evaluate the potential for sediments from the Big Eddy archaeological site to yield opal phytolith assemblages. Phytolith assemblages may provide information on both past environments and human plant use.
>
> Four grams of air-dried sediment were used for each phytolith extraction. The extraction of the phytoliths from these sediment samples consists of four steps (Fredlund 1986): (1) the removal

of carbonates with a dilute (10%) solution of hydrochloric acid; (2) removal of clays by deflocculation with a 0.1 molar solution of sodium hexametaphosphate; (3) heavy liquid fractionation of the biogenic silicates from the heavier mineral fraction with a zinc bromide solution at 2.35 specific gravity; and (4) the washing and storage of the extracted phytolith fraction in 1-dram vials. A 5-micron pore membrane was used to insure that no phytoliths were lost during removal of the clays and during recovery of the phytoliths suspended in the heavy liquid. The dried fractions (materials less than specific gravity of 2.35) were weighed for each sample. This weight is expressed as a percentage of the air-dried weight of the original sediment sample. A single slide was prepared for each sample. A glycerin solution was used as the mounting medium. The use of glycerin allows for rotation of the microfossils under the coverslip for more accurate classification. Slides were systematically scanned at 400X magnification with a Leitz Laborlux-S microscope. Higher magnification, up to 1000X, was used for identification of problematic microfossils.

All of the samples analyzed contained some identifiable phytoliths. However, the quantity and preservation suggests that dissolution and destruction of some biogenic opal has occurred. It is not yet clear to what extent this problem will limit the usefulness of the opal phytoliths.

GEOMORPHOLOGY AND GEOARCHAEOLOGY



Edwin R. Hajic, Rolfe D. Mandel,
Jack H. Ray, and Neal H. Lopinot

A preliminary geoarchaeological investigation of the Big Eddy site was conducted to provide a geologic context for interpretation of the archaeological record. Stratigraphy, geometry, and integrity of deposits containing Paleoindian material were of particular concern. Lithostratigraphic and pedostratigraphic frameworks are defined and described, sedimentary environments are interpreted, and absolute and relative time relationships are presented. In addition, Holocene bioclimatic changes are inferred from isotopic data and a history of Holocene landscape evolution is reconstructed.

METHODS

Field Methods

Although the cutbank at the site gave some indication that thick, stratified prehistoric cultural deposits were present at Big Eddy, excavations were designed without benefit of any geoarchaeological assessment from previous investigations in the valley. Geomorphic fieldwork could not precede excavations, the preferred sequence of events, but rather was conducted simultaneously with them. Investigation initially involved reconnaissance of the area in and around the Big Eddy site to better understand the general geomorphology and relative geomorphic history of the lower Sac River valley. Landforms identified on topographic maps and air photos were field checked. Initial impressions of landform-sediment assemblages were developed by examining the cutbank at the site. During a canoe survey from the dam impounding Stockton Lake to about 2 km downstream of the site, other extensive cutbank exposures were also investigated. Following field reconnaissance, the walls of initial backhoe trenches were inspected. Two profiles were selected for detailed description and soil sampling. At various stages of the excavations, profiles were examined, described, and probed. A trailer-mounted Giddings hydraulic soil probe (see Figure 6.8) was used to take 19 cores in the site area (Figure 7.1) to trace culture-bearing paleosols and develop an understanding of the geometry of lithostratigraphic units and lithofacies. Core 13 was preserved as a record of the site, and it is not described.

Soils were described using standard procedures and terminology outlined by Soil Survey Staff (1992) and Birkeland (1984) (Appendix 3). Graphic sediment-soil logs were constructed to visually convey stratigraphic and contextual information.

Laboratory Methods

Various physical and chemical analyses were performed to characterize and confirm field descriptions of stratigraphic units and soils at the site, and assist in interpretation of depositional processes and postdepositional weathering. Two columns of samples were analyzed for particle-size distribution, total and organic carbon, available and total phosphorus, pH, and clay mineralogy. Core 2, adjacent to both Block B and the cutbank section described in detail, was analyzed at the University of Texas Soil and Crop Sciences Laboratory. A column from Block B was analyzed by the University of Wisconsin–Milwaukee Soil Laboratory. Results are tabulated in Appendix 4.

Particle-size distribution of soil and sediment samples was determined using a modification of

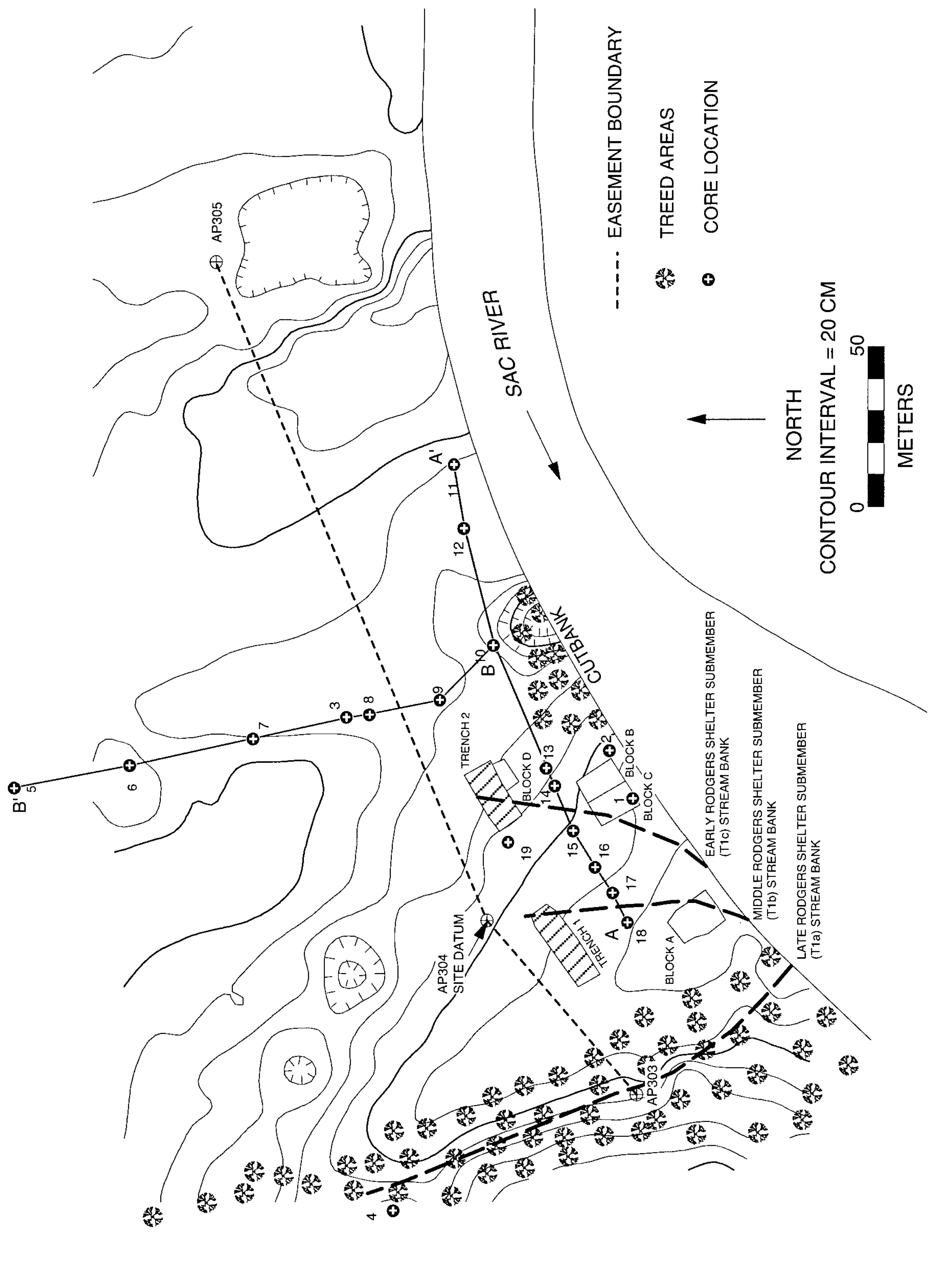


Figure 7.1. Location of sediment/soil cores and plan of 1997 test excavations. Elevation of site datum is approximately 235.9 m asl.

the pipette method developed by Kilmer and Alexander (1949) and by sieving (Gee and Bauder 1986). Silt divisions of USDA NRCS (0.05–0.002 mm) were determined for Core 2, and geologic silt divisions (62.5 μm) were determined for the Block B column. With the exception of the A horizons of soils, organic-matter contents were low enough that the samples did not require pretreatment for organic-matter removal.

For the Block B column, total carbon was determined by dry combustion in a Carbon Serba CHN Elemental Analyzer following machine methods (Page et al. 1982). For both sample columns, organic carbon was determined using the Walkley-Black method (Janitzky 1986). Total and available phosphorus were determined colorimetrically using methods adapted from Greenberg et al. (1992), Olsen and Sommers (1982), and Schulte et al. (1987). pH was determined at a 1:1 (Core 2) and 1:2 (Block B column) ratio (McLean 1982).

Clay-mineral percentages were determined by Charles Rovey, Southwest Missouri State University (Core 2) on a Scintag X-ray diffractometer and by Mary Jo Schabel, University of Wisconsin–Milwaukee (Block B column) on a Seimens-Nicolet X-ray diffractometer, following the Glass method as described by Hallberg et al. (1978). Percentages are based on X-ray diffraction of oriented aggregates of the <2-μm fraction on glycolated slides. Two additional indexes based on the X-ray diffraction results were determined for the Core 2 samples. The HSR (heterogeneous swelling ratio) is the maximum counts per seconds (CPS) at the expandables peak divided by the width of the reflection in degrees two-theta. It is a measure of the degree of pedogenic weathering. In an ideal solum, the HSR initially increases downward as the crystallinity of the expandable clays degrades and the peak lengthens and narrows, then decreases downward as illite is less degraded and peak heights decrease. The diffraction index is a ratio of the maximum CPS at the illite peak divided by the maximum CPS at the kaolinite plus chlorite peak. Thus, in an ideal solum, the DI (diffraction index) should have a fairly steady increase downwards.

Forty-five soil samples were submitted to Geochron Laboratories for stable carbon isotope analysis of organic carbon. Charcoal fragments, roots, and $CaCO_3$ were removed during sample preparation. Soil organic matter was converted to CO_2 for mass spectrometric analysis by dry combustion with CuO in evacuated, sealed quartz tubes at 850°C. The CO_2 was purified and isolated by cryogenic distillation, and its isotopic composition determined on a VG-903 duel inlet, triple-collector isotopic-ratio mass spectrometer.

Three undisturbed cubes of soil were collected for micromorphological analyses: one from the upper 10 cm of the 3Ab horizon, one from the middle of the 3Ab horizon, and one from the lower 10 cm of the 3Ab horizon. These samples were removed from Column 3 in the east wall of Block B. The cubes were placed in sealed containers and shipped to Spectrum Petrographics, Inc. (Winston, Oregon), for thin-section preparation. The thin sections were mounted on large-format slides (51 x 75 mm) with cover slips. The thin sections were sent to Dr. Paul Goldberg (Boston University) for micromorphological analyses. Dr. Goldberg scanned the slides with a binocular microscope and prepared photomicrographs that show representative soil features.

GEOMORPHOLOGY

Within the Sac River valley, prehistoric cultural deposits at the Big Eddy site are on and within a T1a terrace landform-sediment assemblage. The site is associated with an extensive terrace remnant that encompasses at least three-quarters of the valley width (Figures 7.2). This is the most extensive geomorphic surface within the Sac River valley downstream of the dam. As the Sac River crosses the valley westward, a meander migrating northward is actively truncating the southern margin of the T1a terrace remnant at the site and depositing a point bar on the opposite side of the river. Upon encountering the western bedrock valley wall, the Sac River cuts a scour hole and makes an acute turn to the north-northwest to flow adjacent and parallel to the western valley wall. Along this reach between the river channel and the T1a remnant lies a narrow but continuous sliver of high floodplain labeled a T0b surface (Figure 7.2). Multiple terrace levels higher than the T1a surface are present within the Sac River valley upstream and downstream of the reach in which the site is situated. These terraces are bedrock strath terraces overlain by thin increments of gravel, sand, and finer material. They are pre-Holocene in age and not considered further in this report.

The T1a surface is about 5 m above mean low water level (excluding releases from Stockton Lake). Pasture and row crops are the dominant vegetation cover on the T1a. The T1a remnant at the site

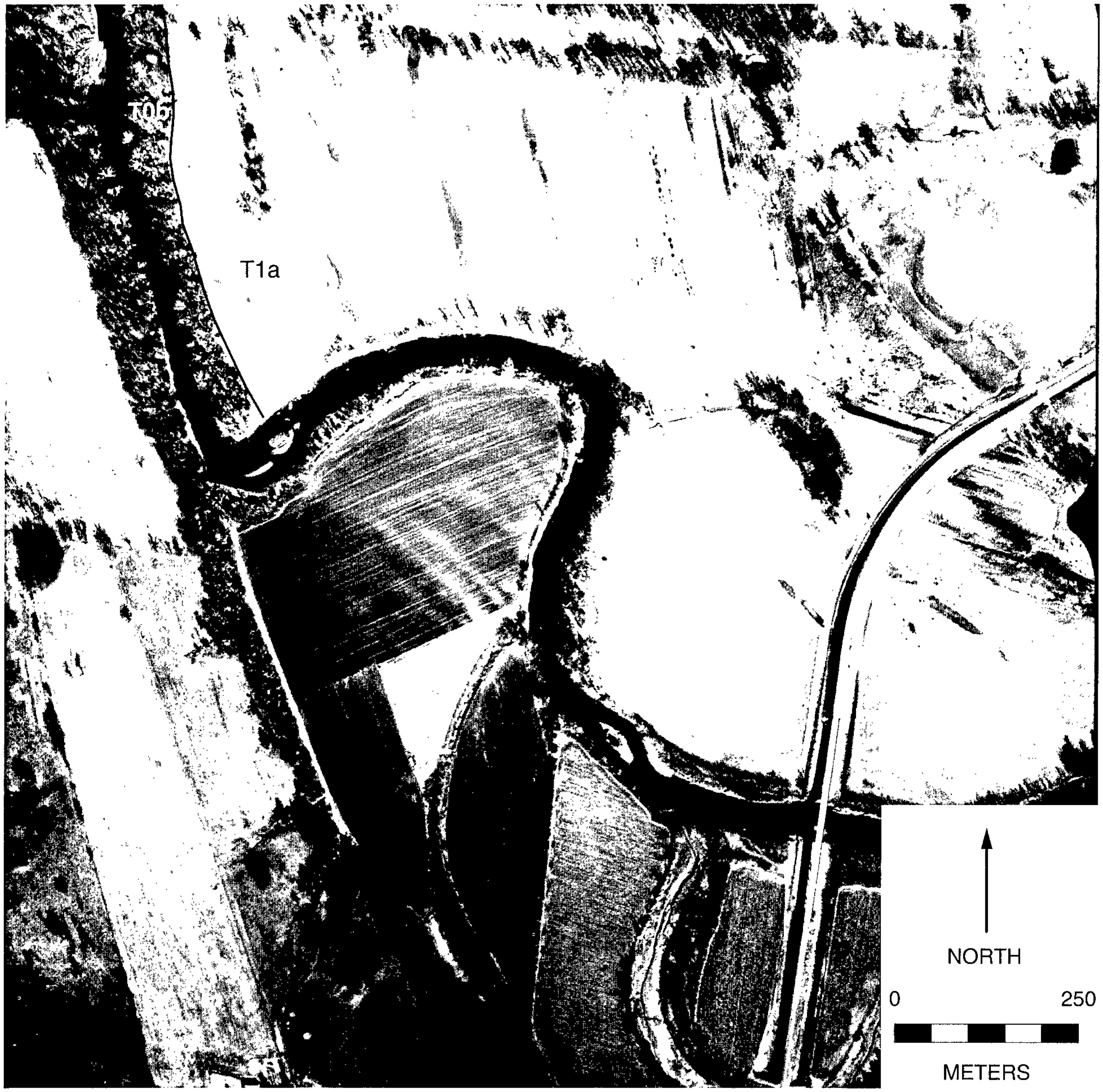


Figure 7.2. Vertical aerial photograph of the Big Eddy site vicinity illustrating major geomorphic surfaces.

is characterized by chutes oriented north-northwest, roughly parallel with the western valley wall (Figures 7.1 and 7.2). Depression relief typically is on the order of 50 cm but may be up to 90 cm. The depressions are late modifications of the T1a surface resulting from historic and possibly late-prehistoric scouring by overbank floods. Hand probes in depressions show that the sediments and soil immediately underlying the T1a surface are truncated.

The T0b surface is about 1.2 m below the T1a surface, or about 3.8 m above mean low water level; it is covered by forest. Historic floods are known to overtop this surface. The riverside flank of this surface has discontinuous sandy and silty flood deposits draped onto it. The top of these drapes can be considered a T0a surface.

The T0b surface abruptly descends to the active river channel. The Sac River is characterized by a meandering channel thalweg with fine to medium chert-pebble gravel. Gravel and sandy gravel channel bars occur on alternating sides of the thalweg in straighter reaches. Where broad meanders are present, there is typically an active cutbank on the outside of meanders and a point bar on the inside. Point bars such as the one south of the site rise less than about a meter above mean low water, exhibit a sandy lower to middle point bar capped by a mud-dominated upper point bar, and support a young stand of softwood trees and weeds.

STRATIGRAPHY AND SEDIMENTOLOGY

Two Holocene alluvial lithostratigraphic members are represented at the site. The older, correlative with the Rodgers Shelter Formation (Haynes 1985) and here referred to as the Rodgers Shelter member, contains prehistoric cultural deposits. It consists of three depositional units—the early, middle, and late submembers—that are subtly different lithologically but clearly distinguished by the cultural deposits they contain and by distinct, moderately expressed buried soils. The younger member, correlative with the Pippins Cemetery Formation (Haynes 1985) and here referred to as the Pippins Cemetery member, has a lithology that contrasts with the Rodgers Shelter member. An unnamed, discontinuous third member is present south of the Sac River. It consists of recent point-bar and floodplain overbank deposits left in the wake of Sac River meander migration and flooding; it is not considered further in this report. Although originally defined as formations (Haynes, 1985), the Rogers Shelter and Pippins Cemetery are here considered members of the same unnamed alluvial formation. This change in lithostratigraphic rank makes the Sac River units comparable in scale to formally and informally defined alluvial members of terminal Pleistocene and Holocene age in neighboring states (i.e., Autin 1996; Bettis 1990; Hajic and Wiant 1997; Mandel 1988; Willman and Frye 1970).

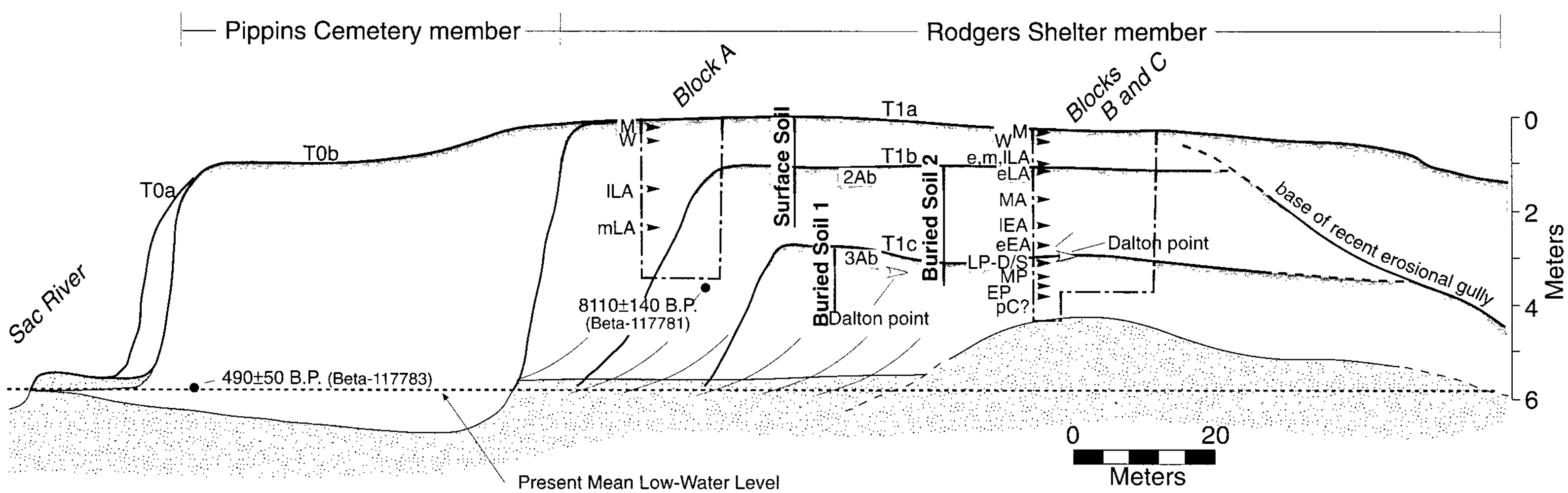
The general cultural stratigraphy of the site is presented below and placed into stratigraphic, pedogenic, and paleogeomorphic context. Detailed descriptions and discussions of the cultural components are presented in Chapter 8.

Rodgers Shelter Member

The Rodgers Shelter member underlies and is associated with the T1a terrace and associated buried paleogeomorphic surfaces (T1b and T1c) (Figures 7.3–7.6). The early, middle, and late submembers of the Rodgers Shelter member underlie the T1c, T1b, and T1a geomorphic and paleogeomorphic surfaces, respectively. Overall, the Rodgers Shelter member predominantly consists of up to at least 5.5 m of pedogenically altered fine-grained alluvium (Figures 7.7 and 7.8). Sediment grain becomes coarser toward the base of the local section.

Early Submember

The T1c paleogeomorphic surface, the underlying early Rodgers Shelter submember, and the associated Buried Soil 1 were identified in several locations: the Sac River cutbank; Blocks B, C, and D; Trench 2; and a number of cores on the east side of the site. In the cutbank, from a point south of Blocks B-C, the 3Ab horizon of Buried Soil 1 could be traced southwestward to a point immediately southeast of Block A (Figure 7.3). To the northeast, it could be traced to and beyond the drainage swale south of Core 10 where it was truncated by the historic swale. In the cutbank, the T1c surface is characterized by low-relief ridges and swales with a frequency on the order of 40–50 m. Along Transect A (Figure 7.1), Buried Soil 1 was recognized in Cores 10–14 north and east of Blocks B and C (Figure 7.4). It was also recognized in Cores 1 and 2 in the vicinity of Blocks B and C. Along Transect B (Figure 7.1), Buried Soil 1 was recognized in Cores 5 and 10 (Figure 7.5). In the western parts of Blocks C and D and



Floodplains, Terraces, Paleogeomorphic Surfaces	Lithostratigraphy	Pedostratigraphy		Cultural Stratigraphy
T0a	modern/Historic	Surface Soil		
T0b	Pippins Cemetery member	Surface Soil		
T1a	Rogers Shelte rmember late	Surface Soil	M	Mississippian
			W	undifferentiated Woodland
			ILA	late Late Archaic
			mLA	middle Late Archaic
			eLA	early Late Archaic
T1b	middle	Buried Soil 2	eLA	early Late Archaic
			MA	Middle Archaic
			IEA	late Early Archaic
			eEA	early Early Archaic
T1c	early	Buried Soil 1	LP-D/S	Late Paleoindian (Dalton, San Patrice)
			MP	Middle Paleoindian
			EP	Early Paleoindian
			pC?	pre-Clovis?

Figure 7.3. Schematic stratigraphic profile of Sac River cutbank at the Big Eddy Site. Note that the positions of Blocks A-C are presented schematically to illustrate their general relationship to the stratigraphy in the cutbank.

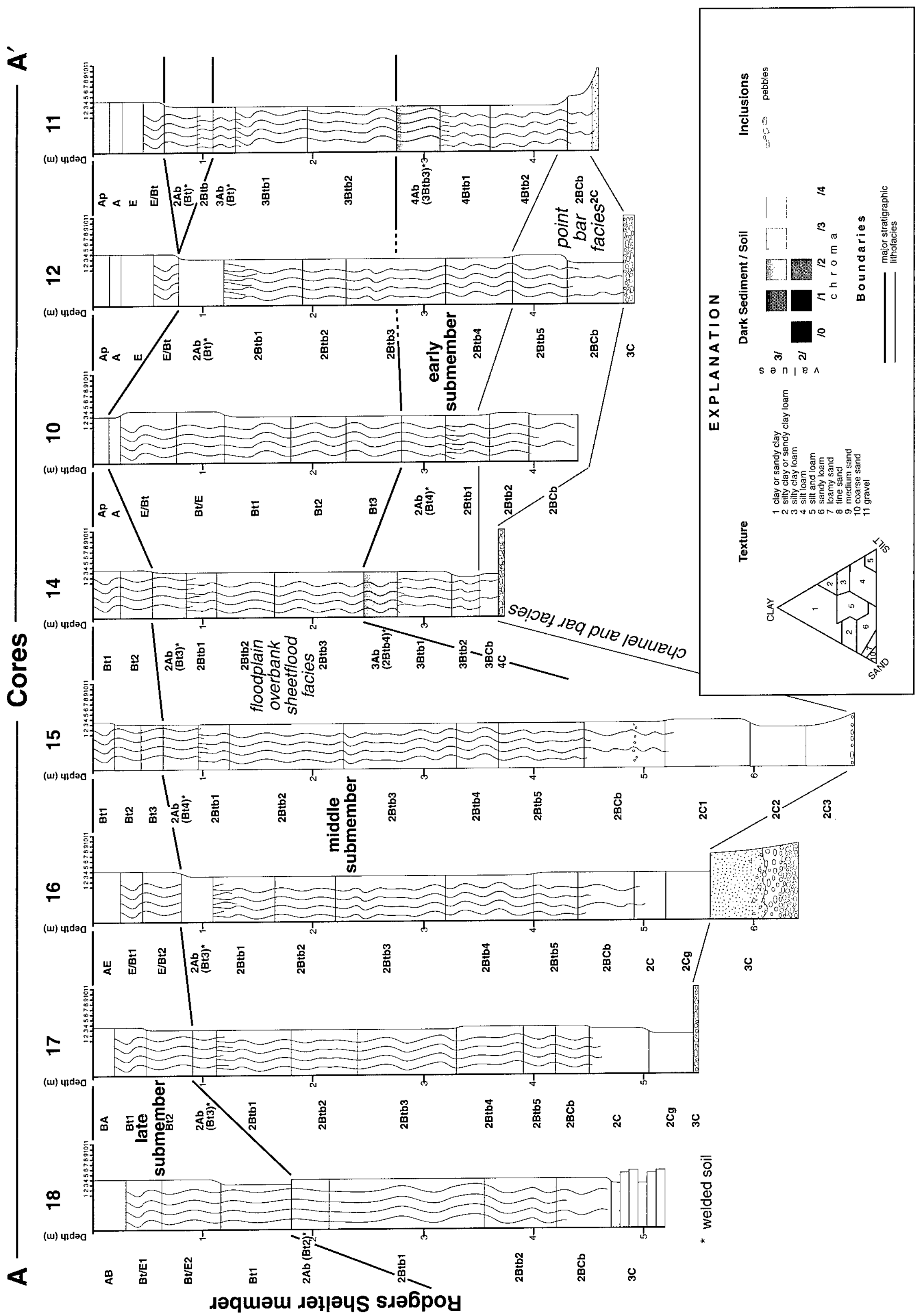


Figure 7.4. Graphic sediment-soil logs along Transect A.

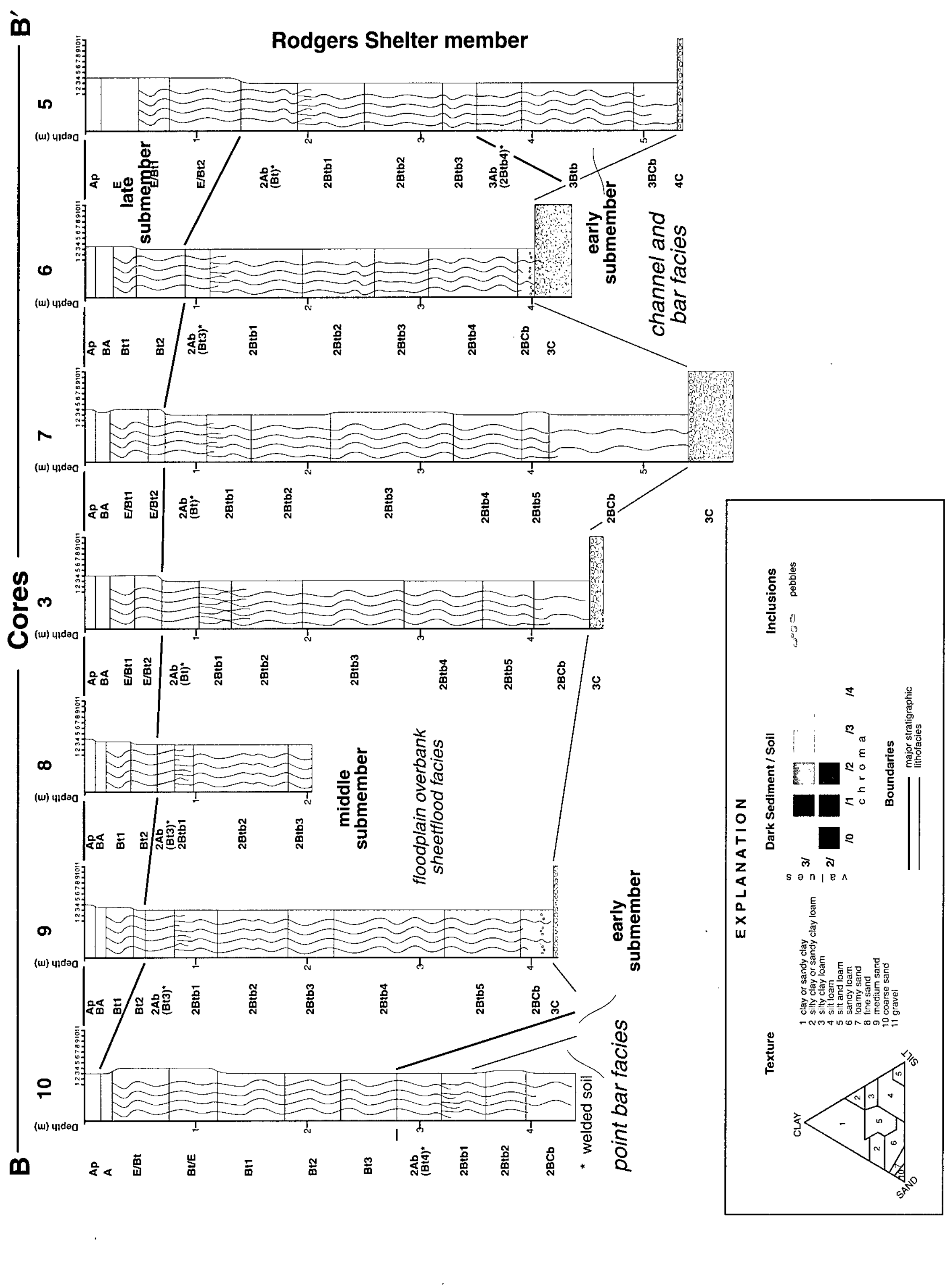


Figure 7.5. Graphic sediment-soil logs along Transect B.

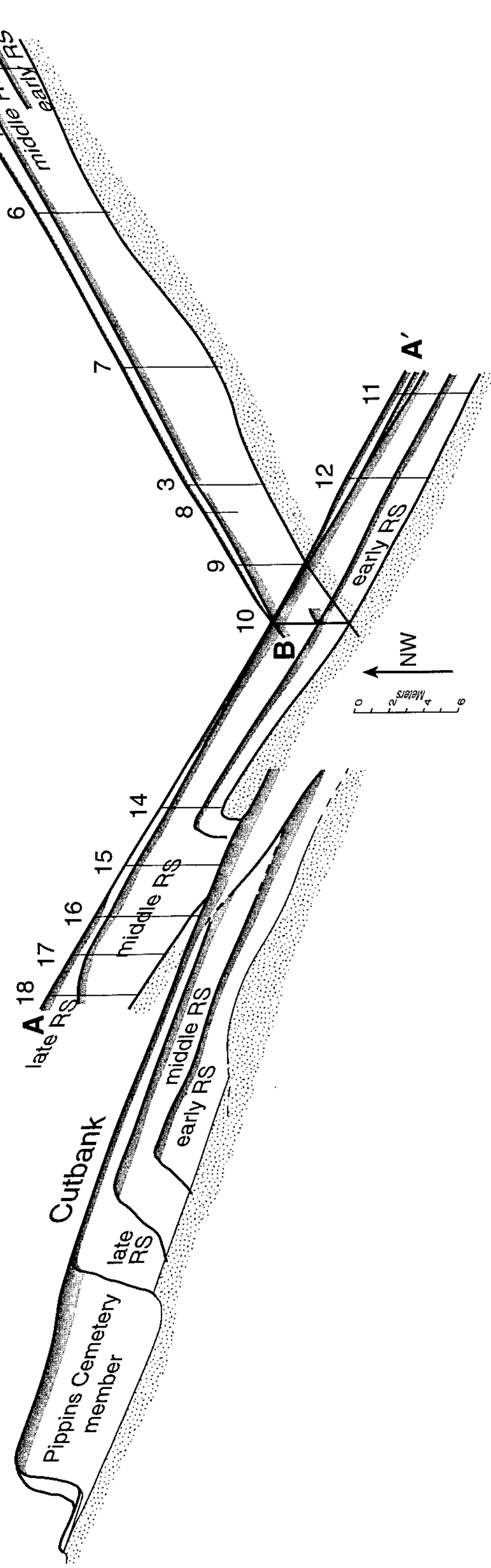


Figure 7.6. Stratigraphic fence diagram of core transects and cutbank.

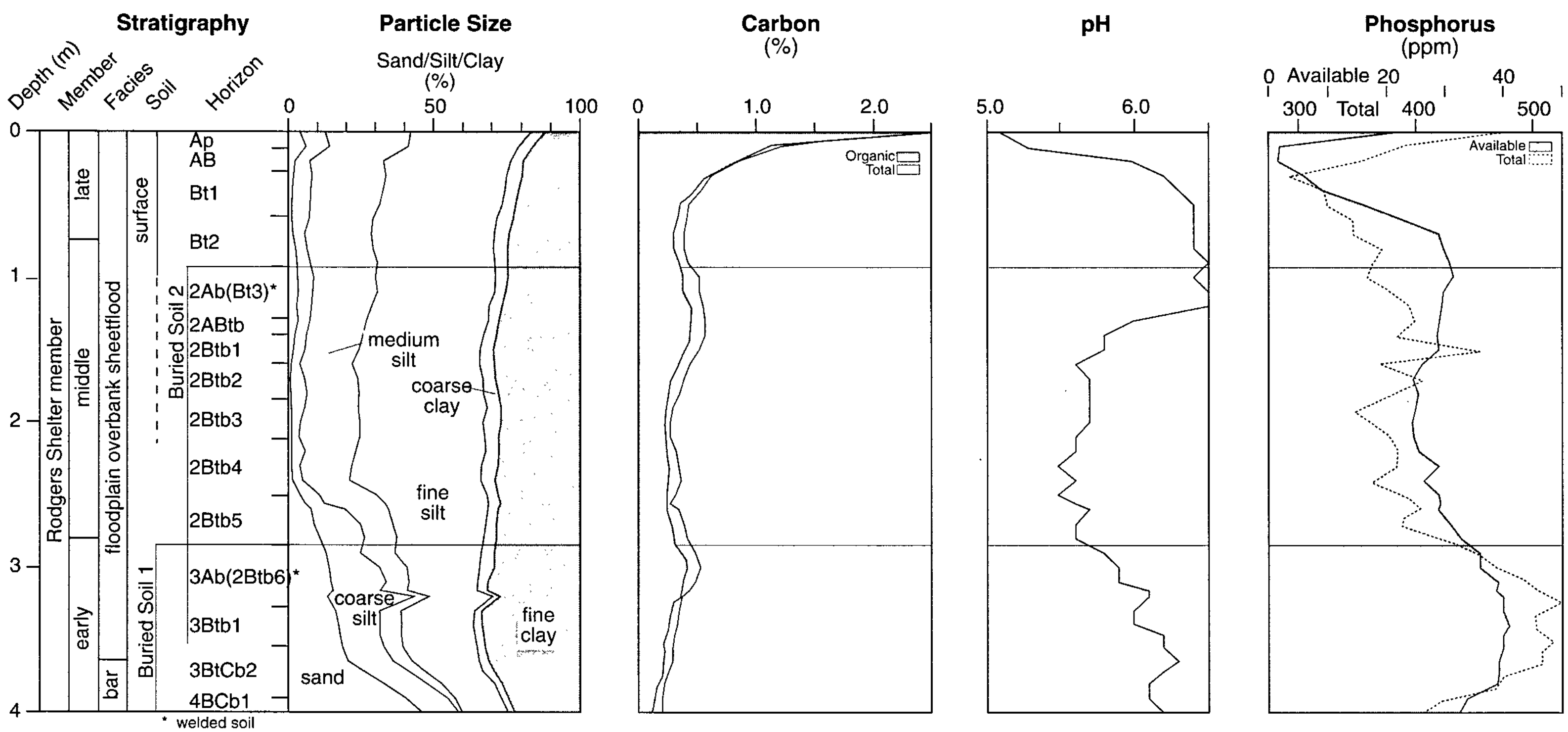


Figure 7.7. Stratigraphy, particle size, carbon, pH, and phosphorus for continuous column in Block B (vicinity of TU 3 and TU 4).

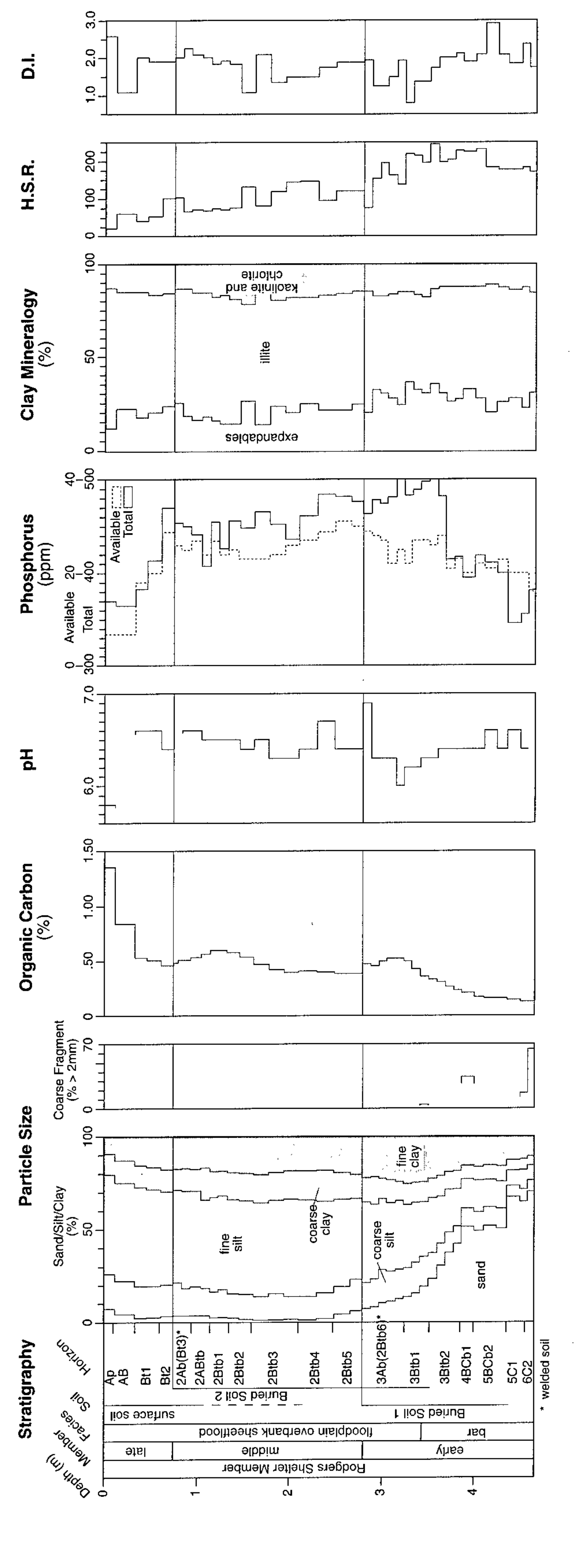


Figure 7.8. Stratigraphy, particle size, organic carbon, pH, phosphorus, and clay mineralogy for Core 2.

in the cutbank, the T1c surface abruptly descends to the west-northwest and the Buried Soil 1 A horizon rapidly terminates. This descent marks a scarp representing a former stream bank and, by inference, a paleochannel position associated with the T1c paleogeomorphic surface (Figure 7.1). The extent of the early submember to the east of Blocks B and C has yet to be traced beyond Core 11. To the north, it is present in Core 5, but it was not recognized in cores between Cores 5 and 10. Reconnaissance observations of cutbanks from the Stockton Dam downstream to below the site indicate that Buried Soil 1 and the early Rodgers Shelter submember are present elsewhere within the Sac River valley.

In the vicinity of the excavations, the early Rodgers Shelter submember consists of an upward-fining sequence (Figures 7.4, 7.5, 7.7, and 7.8). An increment of dark brown (10YR 3/3) silty clay loam grades downward to a dark yellowish brown (10YR 3/4, 4/4) clay loam with very few to few granules and fine subangular chert pebbles. The coarser clasts appear restricted to individual thin beds above a basal gravel (Figure 7.8). The silty clay loam probably was originally bedded or laminated, but any original bedding is masked by pedogenic alteration. Krotovina and other evidence of bioturbation are relatively infrequent. Where examined, there are few discontinuous, tabular, nearly horizontal gravel and gravely loam strata interbedded in the upper half of the clay loam increment and sometimes occurring at the top of the clay loam. One such bed was found in Blocks B and C and in adjacent cores (Figure 7.4). The bed exhibits a gentle west to west-northwest dip and is occasionally penetrated by relatively large, filled animal burrows or tree-root systems. The clay loam rapidly grades downward to a dark yellowish brown (10YR 3/4, 4/4) sandy clay loam and sandy loam, also with very few to few fine chert pebbles. Within the sandy clay loam and sandy loam, weakly expressed low-angle cross-stratification with apparent dips to the southwest is evident in the cutbank under certain moisture conditions. Groundwater moving through the sandier laminae is discharged at the cutbank face, and the laminae may remain moist when the rest of the cutbank is dry. At the base of the section, clast-supported fine to coarse pebble gravel with a discontinuous sandy loam to clay loam matrix to gravely sand extends to below water level and, with one exception, has a nearly horizontal top. The exception occurs south of Blocks B and C where fine pebble to fine cobble gravel forms a local paleotopographic high (Figure 7.3). This topographic high extends an undetermined distance to the north, as indicated in Transect A (Figure 7.6). The top of this slightly coarser gravel rises on the order of 75 cm above the top of any other gravel exposed in the cutbank.

Sedimentologically, the uppermost silty clay loam was deposited as an overbank sheetflood facies on a former floodplain that was actively aggrading vertically. The clay loam to sandy loam with low-angle cross-stratification represents a middle to upper point-bar facies deposited by lateral and vertical accretion as the Sac River channel migrated through the site area. The lateral accretion of point bars was coeval with, and spatially distinct from, the vertical aggradation of the floodplain overbank sheetflood facies. The apparent dip on cross-stratified deposits and the dip on the locally extensive gravel bed coupled with the orientation of the former T1c stream bank indicates that meander migration was to the west and north. Basal pebble gravel and gravely sand was deposited as channel-bar and lower point-bar facies. The notably coarser pebble to cobble gravel body represents a channel-bar facies. The coarser gravel content and slightly higher elevation suggest that it was deposited under a somewhat different, possibly braided, stream regime. If this is the case, it is likely slightly older than the immediately surrounding point-bar facies.

In the upper part of the early Rodgers Shelter submember, internal primary stratification was undetectable in the field because most of this submember is pedogenically altered by Buried Soil 1, which extends downward from the T1c surface (Figures 7.3–7.8). Buried Soil 1 has a 3Ab(2Btb)–3Btb–4BCb1–5BCb2–5C1–6C2 profile in the cutbank and Core 2 (Figures 7.3 and 7.8). The 3Ab horizon is a brown (10YR 3/3) to very dark grayish brown (10YR 3/2) silty clay loam. It has weak, coarse, prismatic breaking to moderate fine and medium subangular and angular blocky structure and firm consistence. Discontinuous thin clay films line ped faces and pores. The organic carbon content in Core 2 shows a broad peak, with content increasing from 0.48% downward through the 3Ab horizon, peaking near the base of the horizon at 0.53%, and gradually decreasing with depth in the upper 3Bt horizons (Figure 7.8). In Block B it increases from 0.31% to 0.43%, then decreases to 0.31%. pH ranges from 6.9 down to 6.0, but in Core 2 it ranges from 5.8 to 6.1. Total phosphorus in-

creases from 464 to 505 ppm (453 to 505 in Block B) while available phosphorus decreases from 29 to 25 ppm (36 to 40 ppm in Block B).

Many of the micromorphological features observed in the upper 10 cm of the 3Ab horizon are typical of a former epipedon. For example, the matrix is rich in finely divided organic matter, and there are abundant voids, most of which are round, sand-sized pores (Figure 7.9a). Also, many of the peds show extensive "washing," or removal of the fine fraction from the matrix (Figure 7.9a). The coarse prismatic structure exhibited in the 3Ab and upper 3Btb horizons is at least in part due to lower Bt horizons of the overlying Buried Soil 2 being welded onto the upper horizons of Buried Soil 1. Some of the micromorphological features observed in the upper 3Ab horizon are more typical of a B horizon and support the field observations of welding. Specifically, dark reddish brown, finely laminated dusty to limpid clay coatings that are 20–300 μm thick (but mostly about 30 μm thick) occur within pores and between some of the peds in the upper 10 cm of the 3Ab horizon (Figures 7.9b and 7.9c).

The micromorphology of the middle of the 3Ab horizon is similar to the micromorphology of the upper 10 cm of this horizon. The finer subangular blocky structure is evident in the middle 3Ab horizon (Figure7.10a). However, there is generally less organic matter in the matrix and less illuvial clay in pores and between peds in this sample (Figure 7.10a and 7.10b). In addition, there are considerably fewer zones of washing in the middle of the 3Ab horizon, and most are very small and confined to voids (Figures 7.10c and 7.10d).

Micromorphological analysis revealed that the lower 10 cm of the 3Ab horizon is more enriched in clay coats than the upper and middle part of this horizon. There appears to be a greater amount of illuvial clay as well as clay that has been integrated into the matrix (Figure 7.11). Given the abundance of illuvial clay, the material composing the lower 10 cm of the 3Ab horizon is more typical of what is found in the upper part of a Bt horizon, and the horizon may more aptly be an ABt horizon. This inference is also illustrated by the thick illuvial coatings in the voids (Figures 7.11c and 7.11d). Other features observed in the lower 10 cm of the 3Ab horizon include reworked pieces of iron concretions, silty textural accumulations in zones of clay illuviation (Figures 7.11a and 7.11b), and secondary Mn/Fe in the form of spotty impregnation and void coatings and linings (Figure 7.11c). The presence of secondary Mn/Fe and the abundant silty and clayey void accumulations suggest the presence of greater amounts of perched and/or percolating water.

The 3Btb horizons consist of a dark yellowish brown (10YR 3/4, 4/4) to strong brown (7.5YR 4/6) silty clay loam that grades downward to a clay loam. They have weak to moderate, medium to coarse, subangular to angular blocky structure, thin discontinuous clay films on ped faces and lining pores, and firm consistence. The 4BCb1 and 5BCb2 horizons are a dark yellowish brown (10YR 3/4, 3.5/4) to brown (7.5YR 5/4) sandy clay loam with varying amounts of coarser clasts. There are common fine oxide depletion zones, very weak coarse subangular blocky structure over primary sedimentary bedding that includes low-angle cross-stratification, common fine pores, and firm consistence. The entire early submember is void of primary or secondary carbonates and mainly has mildly acidic pH values (Figures 7.7 and 7.8).

In Core 2, organic carbon decreases from 0.43% to 0.21%; pH increases slightly from 6.2 to 6.4; total phosphorus increases from 482 to 500 ppm, then drops sharply to 413 ppm; and available phosphorus increases from 22 to 28 ppm, then drops to 23 ppm. Similarly, in Block B, organic carbon decreases from 0.36% to 0.23%; pH increases slightly from 6.0 to 6.3, but then decreases back to 6.2; total phosphorus increases from 497 to 515 ppm, then drops to 467 ppm; and available phosphorus remains in the 40–41 ppm range until the lower part of the Bt horizon, where it drops slightly to 38 ppm.

Cultural Stratigraphy. The early Rodgers Shelter submember contains Early, Middle, and Late Paleoindian cultural deposits, and, possibly, pre-Clovis deposits. In the vicinity of Blocks B and C, likely pre-Clovis deposits are found in basal increments of the floodplain overbank sheetflood facies and in the upper point-bar facies, or about 80 to 105 cm beneath the T1c surface. Whereas some of the artifacts and manuports are interpreted as being from disturbed contexts, others were collected from what appear to be undisturbed contexts from above the gravel bed but beneath Early Paleoindian cultural deposits (see Chapter 8).

In the vicinity of Blocks B and C, Early and Middle Paleoindian deposits were identified in sheetflood facies of the early submember. They are located about 320 to 370 cm below ground surface, or about 35 to 85 cm below the T1c surface. Al-

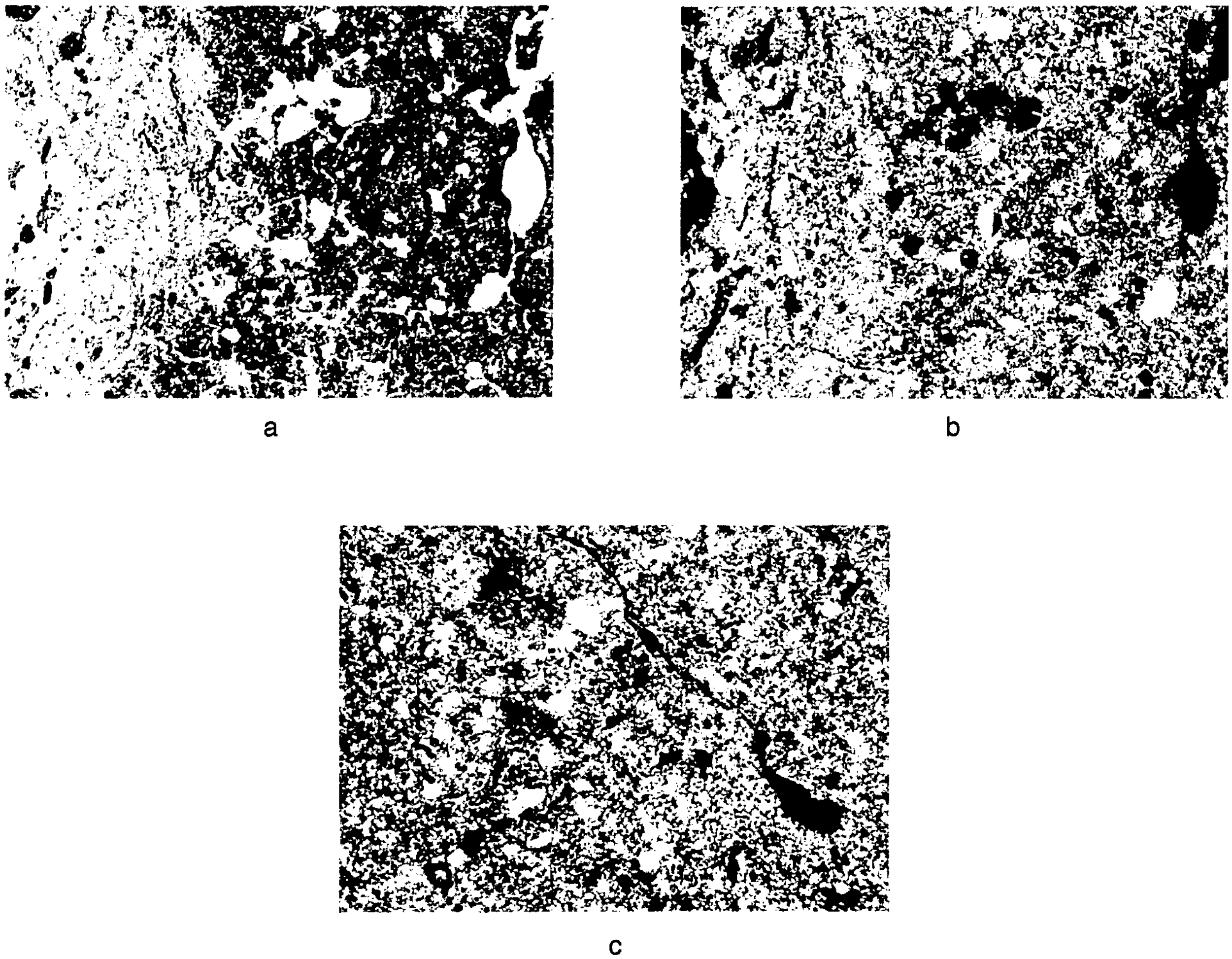


Figure 7.9. Photomicrographs of the sample collected from the upper 10 cm of the 3Ab horizon. (a) Plain polarized light. Note the abundant voids, mostly as circular pores. The matrix is relatively rich in finely divided organic matter, as shown by the dark nature of the lower part of the photomicrograph. In the upper part of the photomicrograph, much of the finer fraction has been washed from the sample, displayed better in Figure 7.9b. The photomicrograph spans 6.3 mm (width). (b) Same as Figure 7.9a, but in cross polarized light. Note the yellowish brown illuvial clay. (c) Cross polarized light. Note the illuvial clay. Lighter patches occur where some of the finer fraction of the matrix has been elutriated. The photomicrograph spans 6.3 mm (width).

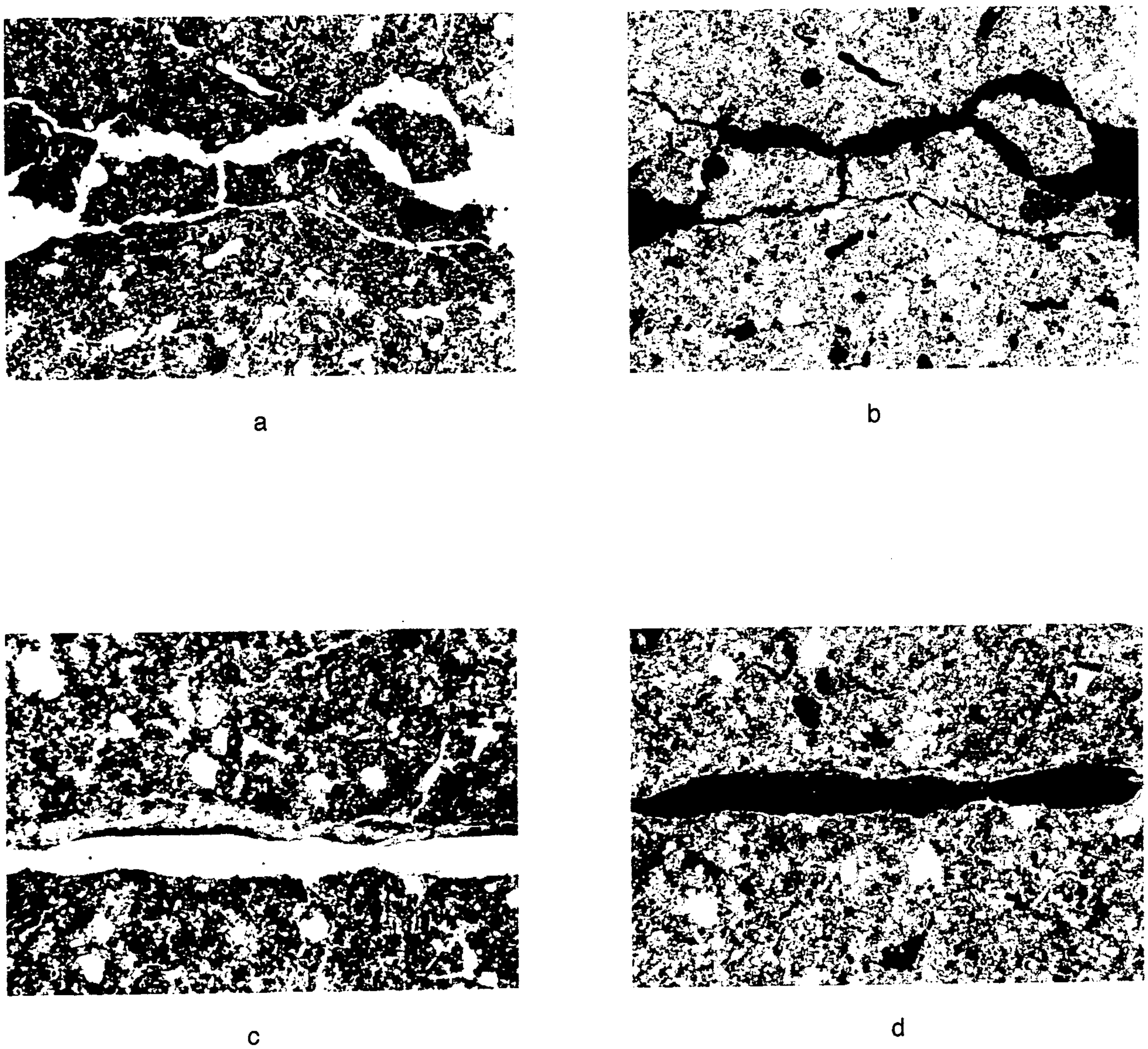


Figure 7.10. Photomicrographs of the sample collected from the middle of the 3Ab horizon. (a) Plain polarized light. The subangular blocky structure is evident here as is the illuvial clay between the peds. Note the slightly cleaner aspect of matrix in comparison to the upper 10 cm of the 3Ab horizon. The photomicrograph spans 6.3 mm (width). (b) Same as Figure 10a, but in cross polarized light. The illuvial clay is very clear in this view. (c) Plain polarized light. In the elongated void in the center, note the clean sand which is overlain by well bedded reddish brown illuvial clay. Overall, there are fewer and smaller areas of elutriated fines. The photomicrograph spans 3.2 mm (width). (d) Same as Figure 10c, but in cross polarized light.

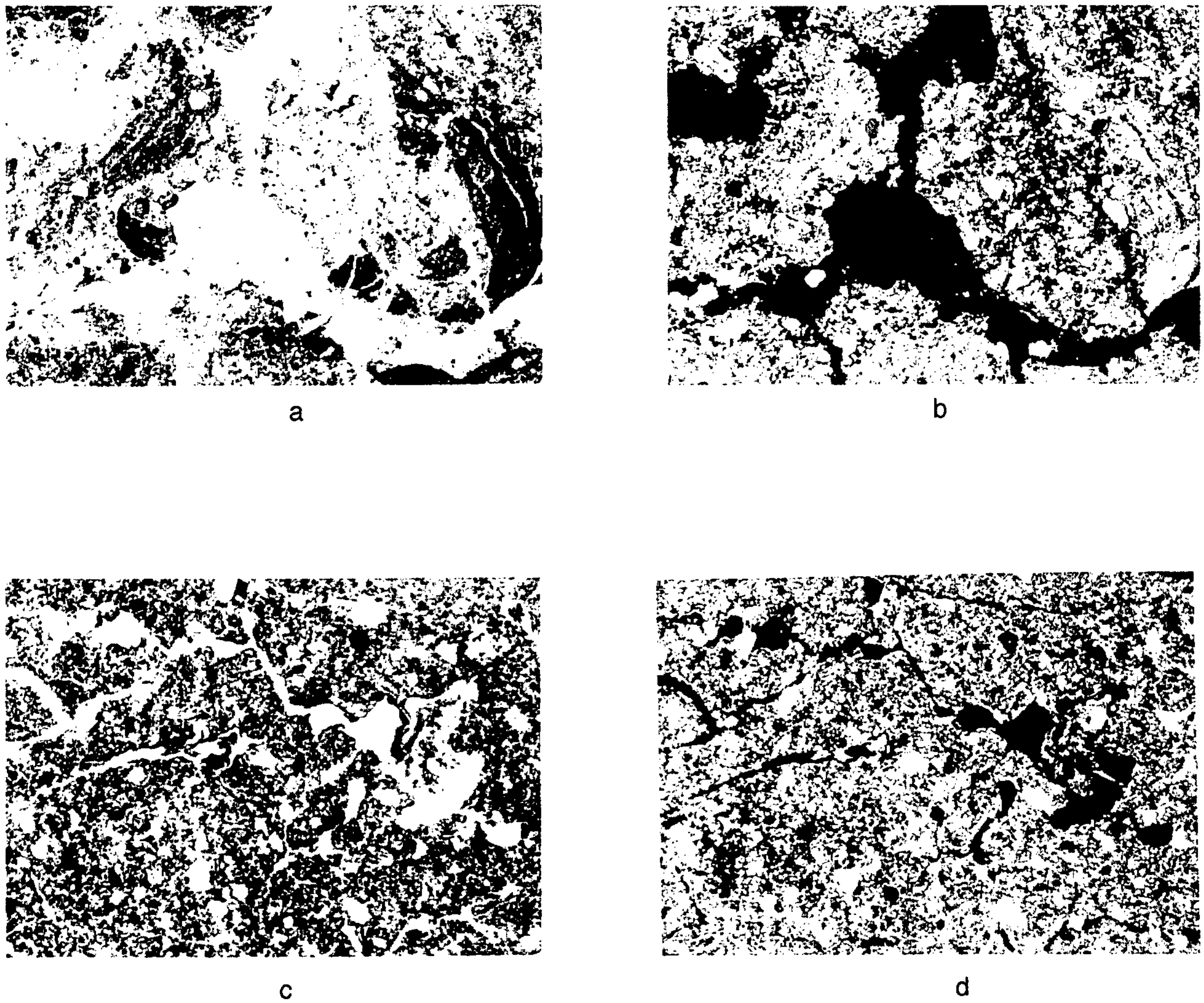


Figure 7.11. Photomicrographs of the sample collected from the lower 10 cm of the 3Ab horizon. (a) Plain polarized light. Note the large void showing infilling of intercalated and bedded clay and silt. The photomicrograph spans 6.3 mm (width). (b) Cross polarized light. The bedded clay is more striking in this view. The photomicrograph spans 6.3 mm (width). (c) Plain polarized light. Note the void filling by the illuvial dusty clay, as well as the blackish spots of iron (Fe) and manganese (Mn) in the left portion of the photomicrograph. These two features suggest a greater presence of water, either as stagnant (perched) or as throughflow (percolation) water. The photomicrograph spans 6.3 mm (width). Note the slightly greater abundance of illuvial clay, both in voids and within the matrix, compared to the middle portion of the 3Ab horizon.(d) Same as Figure 10c, but in cross polarized light.

though there are not enough diagnostic artifacts at this time to differentiate Early and Middle Paleoindian deposits, available evidence suggests the Early to Middle Paleoindian break occurs in the vicinity of a depth of about 336 cm, or about 51 cm below the T1c surface (see Chapter 8). Debris densities are relatively great to a depth of about 350 cm, with the greatest density associated with a living surface at about 330–333 cm below ground surface, or about 45–48 cm below the T1c surface, assigned to the Middle Paleoindian occupation. Below about 350 cm, debris densities decrease markedly, but artifacts are still present.

Late Paleoindian deposits are situated 285 to 320 cm below ground surface in the vicinity of Blocks B-D, or from the T1c surface down about 35 cm, in the youngest sheetflood facies of the early submember. This increment, representing a distinct stratigraphic unit deposited on a temporarily stable paleogeomorphic floodplain surface, is modified by the 3Ab horizon of Buried Soil 1. Late Paleoindian deposits are characterized by relatively great artifact densities.

Geochronology. Radiocarbon ages and pertinent sample information are listed in Table 7.1. Twenty radiocarbon ages were obtained from samples collected from the early Rodgers Shelter submember. Four samples consisted of soil humates extracted from bulk samples 10 cm thick. The remaining 16 samples consisted of minute charcoal fragments that were dated with the AMS technique. Of these, at least 10 were wood charcoal, two were either wood or bark charcoal, and four were unidentified charcoal. None of the pieces could be identified to species under low-power magnification due to their degraded condition. The AMS radiocarbon ages with standard errors are plotted by depth and stratigraphy for the early Rodgers Shelter submember in Figure 7.12.

The samples and ages of the early submember are discussed in three groups related to interpretation of pre-Clovis, Early and Middle Paleoindian, and Late Paleoindian deposits. The first group consists of four samples of wood charcoal collected from the upper point-bar facies (Table 7.1). Three samples were collected from beneath the distinct gravel bed. At a depth of 412 cm, or about 132 cm beneath the T1c surface and 27 cm beneath the top of the gravel bed, sample AA-29021 yielded an age of 10,680 ± 60 B.P. At a depth of 409 cm, or about 129 cm beneath the T1c surface and 24 cm beneath the top of the gravel bed, sample Beta-109008 yielded an age of 12,940 ± 120 B.P. At a depth of 396 cm, or about 116 cm beneath the T1c surface and 11 cm beneath the top of the gravel bed, sample AA-27484 yielded an age of 12,700 ± 180 B.P. The fourth sample was atop the gravel bed at a depth of 384 cm, or about 104 cm beneath the T1c surface. It yielded an age of 11,910 ± 440 B.P (AA-27483).

The age of sample AA-29021, 10,680 ± 60 B.P., is out of stratigraphic position in relation to the other ages and overlying Middle and Late Paleoindian cultural deposits (Figure 7.12). The sample apparently was displaced downward through one of the bioturbation features in the gravel bed. The large standard error on sample AA-27483 (440 years) is unfortunate because it does little to narrow the age of the top of the gravel bed and precludes serious consideration of sedimentation rates for this interval.

There are 10 samples in the second group (Table 7.1).They were collected from the uppermost point-bar facies, where sand content begins to decrease rapidly, and in the oldest sheetflood facies modified by the Bt horizons of Buried Soil 1. Of these, four are wood charcoal, two are bark or wood charcoal, two are undifferentiated charcoal, and two are soil humates from bulk soil samples. All ages are younger than the youngest acceptable age from the first group of underlying samples, 11,910 ± 440 B.P. (AA-27483), obtained from the sample at the top of the gravel bed. Consideration of the large standard error of this sample introduces overlap with sample AA-27486, which yielded an age of 11,900 ± 80 B.P. However, this sample is clearly inconsistent with the remaining nine samples in this group. Excluding the two ages on soil humates, the remaining seven charcoal samples range in age from 10,260 ± 85 B.P. (AA-25778) to 11,280 ± 75 B.P. (AA-27485). All but the youngest age are compatible with expectations for Middle and Early Paleoindian deposits. Internally, there is little apparent stratigraphic order among the uncalibrated ages. This may be due to several factors, individually or in concert. The apparent disorder may be simply a function of the samples being uncalibrated; analysis of calibrated radiocarbon ages has yet to be conducted. Alternatively, vertical mixing of some fine charcoal fragments may have occurred during formation of the Bt horizons of Buried Soil 1. This could include downward movement of overlying charcoal, as well as upward movement of underlying charcoal. The soil humate ages, 11,384 ± 107 B.P. (Tx-9326) and 11,076 ± 86 B.P. (Tx-

Table 7.1. Big Eddy Radiocarbon Dates.

		Calibration Data									
RCYBP	$\delta^{13}C$	Intercept AD/B.P.	1σ	2σ	Soil Horizon	Depth Below Surface (cm)	Cultural Component	Provenience	Material Dated	Weight (g)	Lab Number
Pippins Cemetery member											
490 ± 50	-25.0	AD1435	AD 1410–1450	AD1400–1480	Cg	530	Late Mississippian	Log in cutbank	Uncarbonized wood	43.48	Beta-117783
Rodgers Shelter member											
Late submember											
760 ± 70	-25.0	AD 1280	1225–1295	1165–1390	A2	25	Middle Mississippian	Feature 2	Wood charcoal	18.0	Beta-112983
4020 ± 80	-25.0	4510, 4480, 4450	4565–4410	4820–4260	2Ab(Bt3)	252–260	Late Archaic	Feature 30	Nut shell charcoal	6.66	Beta-109009
4040 ± 100	-25.0	4520, 4470, 4455	4810–4410	4830–4235	2Ab(Bt3)	240–250	Late Archaic	TU 5-25	Wood and nut shell charcoal	30.0	Beta-112984
Middle submember											
4125 ± 45	-25.3	4800, 4775, 4610, 4590, 4570	4815–4535	4830–4540	2Ab(Bt3)	120–130	Late Archaic	TU 2-13	Hickory nut shell charcoal	0.03	AA-29018
4130 ± 45	-24.3	4800, 4770, 4610, 4590, 4575	4820–4540	4830–4450	2Ab(Bt3)	160	Late Archaic	BL-A east wall	Charred bark	<0.5	AA-29020
4497 ± 57	-16.6	5245, 5190, 5120, 5055	5290–4995	5310–4880	2Ab(Bt3)	90–100	Late Archaic	TU 3-2Ab	Soil humates		Tx-9328
5158 ± 54	-15.6	5920	5940–5900	6025–5755	2Ab(Bt3)	120–130	Late Archaic	TU 3-2Ab	Soil humates		Tx-9330
8110 ± 140	-25.0	8990	9240–8725	9430–8550	2Bt3b	345	Middle Archaic	Cutbank, Feature 46	Wood charcoal	23.61	Beta-117781
8190 ± 60	-25.0	9190, 9170, 9150, 9130, 9090, 9070, 9045	9240–8995	9370–8980	2Bt3b	190–192	Early Archaic	TU 3	Wood charcoal	<0.02	AA-29019
9525 ± 65	-23.7	10,785, 10,765, 10545	10,870–10,420	10,925–10,360	2Bt5b	251	Early Archaic	TU 4	Wood charcoal	0.02	AA-27479

Table 7.1 Big Eddy Radiocarbon Dates. (Continued).

RCYBP	$\delta^{13}C$	Calibration Data: Intercept AD/B.P.	Calibration Data: 1σ	Calibration Data: 2σ	Soil Horizon	Depth Below Surface (cm)	Cultural Component	Provenience	Material Dated	Weight (g)	Lab Number
Early-Middle submember contact											
9190 ± 90	-25.0	10,130, 10,120, 10,085, 10,050	10,290–10,035	10,370–9980	2Btb5/ 3Ab(2Btb6)	286	Early Archaic	Cutbank, Feature 39	Wood charcoal	10.1	Beta-112982
Early submember											
9450 ± 61	-17.9	10,425	10,785–10,360	10,865–10,230	3Ab(2Btb6)	290–300	Late Paleoindian	Col 3-3Ab	Soil humates		Tx-9329
10,185 ± 75	-26.2	11,930	12,125–11,640	12,275–11,130	3Ab(2Btb6)	298	Late Paleoindian	TU 21-30	Charcoal	≈0.01	AA-26653
10,400 ± 75	-23.9	12,300	12,420–12,155	12,520–11,975	3Ab(2Btb6)	306	Late Paleoindian	TU 30-31	Charcoal	0.01	AA-27487
10,340 ± 100	-24.7	12,215	12,370–12,010	12,500–11,705	3Ab(2Btb6)	308	Late Paleoindian	TU 17-31	Wood charcoal	0.02	AA-27480
10,430 ± 70	-25.6	12,340	12,450–12,210	12,545–12,050	3Ab(2Btb6)	312–315	Late Paleoindian	TU 26-32	Wood charcoal	<0.02	AA-29022
10,336 ± 110	-17.8	12,210	12,380–11,985	12,520–11,625	3Ab(2Btb6)	310–320	Late Paleoindian	Col. 3-3Ab	Soil humates		Tx-9325
10,470 ± 80	-24.8	12,385	12,500–12,255	12,600–12,095	3Ab(2Btb6)/ 3Btb1	321	Late-Middle Paleoindian transition	TU 35-33	Wood charcoal	0.01	AA-27488
11,280 ± 75	-24.2	13,190	13,290–13,100	13,400–13,010	33Ab(2Btb6)/ 3Btb1	322	Late-Middle Paleoindian transition	TU 26-33	Wood charcoal	0.01	AA-27485
11,160 ± 75	-19.0	13,070	13,160–12,980	13,260–12,895	3Btb1	326	Early/Middle Paleoindian	TU 25-33	Bark/wood charcoal	0.01	AA-27481
10,260 ± 85	-25.0	12,080	12,255–11,855	12,390–11,270	3Btb1	328	Early/Middle Paleoindian	TU 22-33	Wood charcoal	0.001	AA-25778
11,900 ± 80	-21.1	13,870	14,025–13,735	14,185–13,610	3Btb1	331	Early/Middle Paleoindian	TU 26-34	Bark/wood charcoal	0.01	AA-27486
10,710 ± 85	-24.2	12,640	12,740–12,540	12,840–12,420	3Btb1	333	Early/Middle Paleoindian	TU 25-34	Charcoal	≈0.005	AA-26654
11,384 ± 07	-21.4	13,295	13,470–13,170	13,590–13060	3Bt1b	330–340	Early/Middle Paleoindian	Col. 1-3Bt1	Soil humates		Tx-9326

Table 7.1 Big Eddy Radiocarbon Dates. (Continued).

		Calibration Data									
RCYBP	$\delta^{13}C$	Intercept AD/B.P.	1σ	2σ	Soil Horizon	Depth Below Surface (cm)	Cultural Component	Provenience	Material Dated	Weight (g)	Lab Number
11,190 ± 75	-20.5	13,100	13,190–13,010	13,295–12,925	3Btb1	338	Early/Middle Paleoindian	TU 25-34	Wood charcoal	0.01	AA-27482
11,076 ± 86	-21.9	12,990	13,085–12,895	13,190–12,800	3Btb1	340–350	Early/Middle Paleoindian	Col. 1-3Bt1	Soil humates		Tx-9327
10,940 ± 80	-25.2	12,860	12,950–12,770	13,040–12,675	3Btb1	347	Early/Middle Paleoindian	TU 25-35	Charcoal	≈0.01	AA-26655
11,910 ± 440	-25.7	13,885	14,455–13,380	15,130–12,940	3Btb2	384	Pre-Clovis	TU 25-39	Wood charcoal	0.005	AA-27483
12,700 ± 180	-24.9	14,950	15,275–14,635	15,575–14,350	5BCb2	396	Pre-Clovis	TU 25-40	Wood charcoal	0.005	AA-27484
12,940 ± 120	-25.7	15,340	15,565–15,100	15,770–14,835	5BCb2	409	Pre-Clovis	TU 25-39	Wood charcoal	0.1	Beta-109008
10,680 ± 60	-26.9	12,610	12,695–12,525	12,770–12,430	5BCb2	412	Pre-Clovis	TU 25-42	Wood charcoal	<0.5	AA-29021

Note: The RCYBP ages are calculated on a half life of 5,568 years and are corrected for isotopic fractionation. $\delta^{13}C$ values of -25.0 for wood samples are estimated, all other $\delta^{13}C$ values were measured by the dating laboratory. Calibration was performed with CALIB 3.03A (Stuiver and Reimer 1993) using the INTCAL93.14C dataset (Bard et al. 1993)

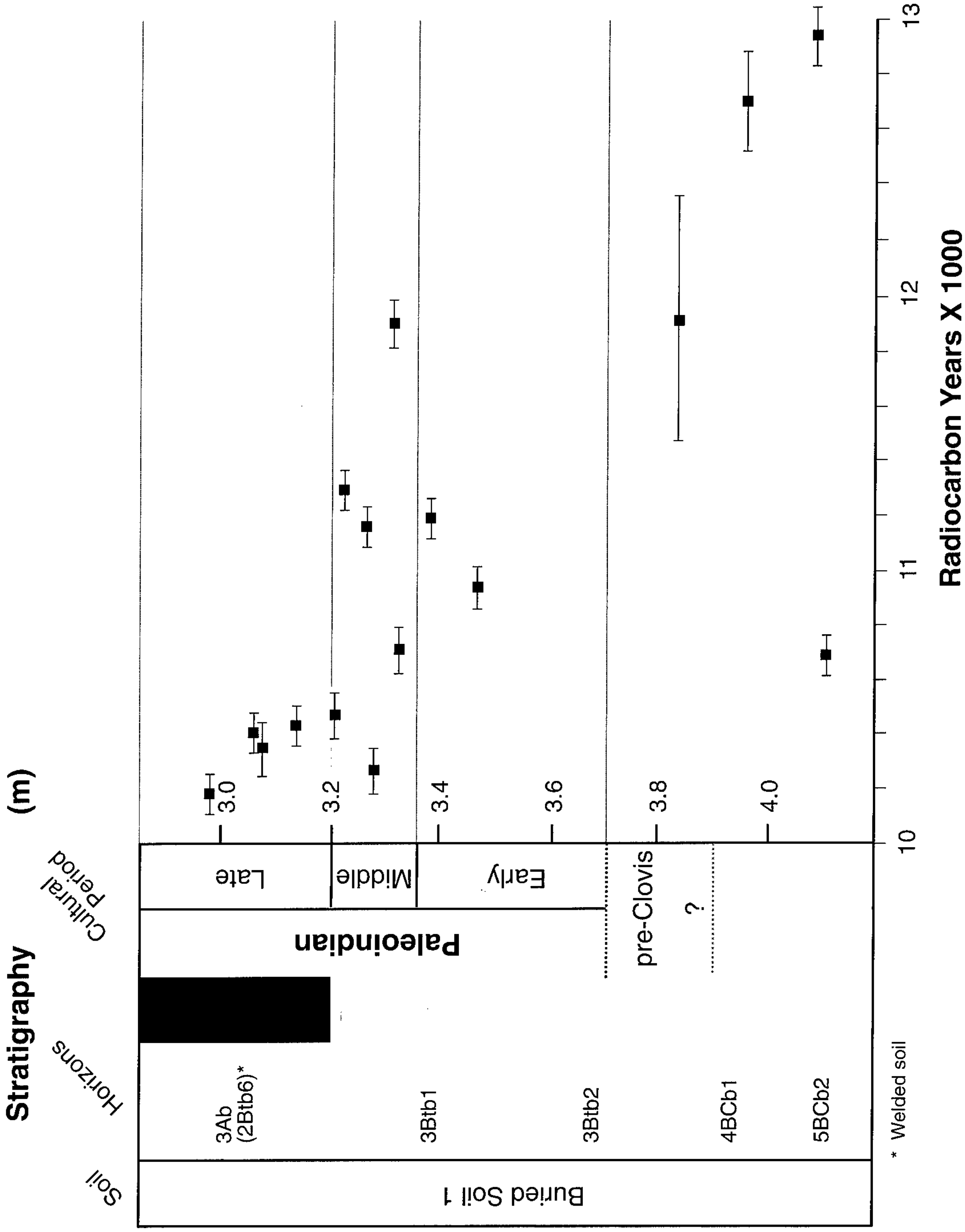


Figure 7.12. Stratigraphy and AMS radiocarbon ages from the early Rodgers Shelter submember.

9327), fall near the older end of this range. If uncontaminated by older carbon (always a concern with soil humate ages), these ages would tend to suggest that vertical movement of charcoal from above, rather than below, is more of a potential problem.

A third possibility is related to depositional environment. It has been demonstrated that charcoal from point bars can yield erroneous ages for deposits they presumably date due to entrainment and resedimentation (Blong and Gillespie 1978). However, Hajic and Wiant (1997) suggest this is not necessarily the case for charcoal in fine-grained floodplain settings due to the more cohesive character of the sediments and the lower likelihood of traction currents. The charcoal in question is from an interval that transitions from the point bar to floodplain environment, so some re-entrainment is possible.

A final alternative is the possibility that the Middle Paleoindian cultural deposits are associated with a paleogeomorphic surface that was subject to pedogenic processes and limited, slow upbuilding prior to burial by the youngest increment of the early submember. The relatively slow upbuilding may have allowed charcoal displacement by human impacts or pedogenic processes.

The third group consists of six samples (Table 7.1). All were collected from the youngest increments of the early submember floodplain overbank sheetflood facies that is also modified by the 3Ab horizon of Buried Soil 1. All were collected in association with Late Paleoindian deposits. Two are wood charcoal, two are undifferentiated charcoal, and two are soil humates from bulk soil samples collected from near the top and at the bottom of the 3Ab horizon. With standard errors considered, all ages are younger than the youngest age from the second group of underlying samples, excluding sample AA-25778 (10,260 ± 85 B.P.). This sample is considered to be redistributed from the 3Ab horizon. The charcoal samples range in age from 10,185 ± 75 B.P. (AA-26653) to 10,430 ± 70 B.P. (AA-29022). Internally, with standard errors considered, they are in stratigraphic order, although three of the four are tightly clustered. The charcoal ages correspond with what would be expected for Late Paleoindian deposits.

The soil humate sample from the base of the 3Ab horizon yielded an age of 10,336 ±110 B.P. (Tx-9325). It is not out of line with the charcoal samples, considering the standard error. The soil humate sample from near the top of the 3Ab horizon yielded an age of 9450 ± 61 B.P. (Tx-9329), some 700 radiocarbon years younger than the youngest charcoal sample in the group. This age is younger than an overlying sample from the middle submember about 35 cm above the T1c surface and the top of Buried Soil 1 (AA-27479: 9525 ± 65 B.P.). However, when standard errors are considered, there is no statistical difference in the ages. Although the age of Tx-9329 is younger than the Late Paleoindian deposits from the same depth, it is not necessarily anomalous. The age is on soil humates, and soil humates are coeval with, or postdate, sediments modified by the soil. The stratigraphic position of these two samples and their ages may suggest that burial of the T1c surface and Buried Soil 1 was relatively rapid. Alternatively, sample AA-27479 may have been vertically mixed upward by pedogenic processes associated with evolution of Buried Soil 2 though this is unlikely.

Discussion. The presence or absence of the 3Ab horizon of Buried Soil 1 is the strongest clue to narrowing down the location of the T1c stream bank. However, north of Block D, the 3Ab horizon is recognized only in Core 5 (Figure 7.1). North of Blocks B and C, from Block D to Core 5, there is an increase in the value and chroma of the 3Ab horizon color reflecting a decrease in organic matter content, and the 3Ab is less well expressed in this area. The former stream bank associated with the T1c surface can be reconstructed with certainty in the vicinity of the cutbank and excavation blocks. It also apparently occurs between Cores 5 and 6 and between Cores 9 and 10 but at uncertain orientations (Figures 7.1 and 7.5). There are two possibilities for channel orientation. The first is that the former stream bank exposed in the modern cutbank and Block C is the same former stream bank between Cores 5 and 6 to the north, implying it curves northeast, then bends towards the northwest. Alternatively, the former stream bank between Cores 5 and 6 may be the bank opposite the one exposed in the cutbank and Block C. In this case, the Sac River formerly would have flowed in a general northeasterly direction.

The organic carbon profile in the 3Ab horizon tends to increase slightly with depth and peaks near the base of the horizon, then decreases gradually with depth. Several factors may account for this pattern. A change in the balance of pedogenic and depositional processes, such as an interval of slightly increased sedimentation rates, could result in less organic carbon in the top of the 3Ab horizon. Sedimentation rates apparently can be determined

reliably for the sediment interval modified by the 3Ab horizon, but at this time are unreliable for underlying deposits (see below). Furthermore, there are hints of a stratigraphic discontinuity in the 315–324-cm depth interval in both Core 2 and Block B (Figures 7.7 and 7.8). In the core, there is a spike in total phosphorus, and, more significantly, there is a subtle shift in clay mineralogy that persists to the top of the 3Ab horizon. Illite increases slightly at the expense of expandables, possibly suggesting a less weathered increment of sediment. Through the 3Ab horizon, the HSR increases with depth, then decreases with depth to 324 cm where it abruptly increases. In a typical soil profile, the pattern ought to be one of a consistently increasing HSR. There is a marked negative spike in the DI at the 315–324-cm depth interval, and, in the 3Ab horizon, it tends to vary inversely with the HSR, rather than directly as expected in the upper part of a soil solum. In Block B, there is a textural discontinuity at 321–323 cm as in Core 2. There is a spike in coarse silt content, and there are corresponding decreases in fine silt, clay, and sand content. This spike is coincident with the base of the main bulge in organic matter content.

The organic carbon could have been translocated downward in clay-organic complexes as the overlying Buried Soil 2 was welded onto the 3Ab horizon. Micromorphology of the 3Ab horizon clearly indicates fine material was removed, possibly taking along organic carbon chelated onto clay-mineral faces.

Finally, the organic carbon profile could be influenced by culturally deposited organic matter. The middle part of the 3Ab horizon tends to be associated with greater concentrations of artifacts (see Chapter 8), possibly suggestive of greater cultural impacts to the soil environment. The apparent trend toward progressively lighter colors for the 3Ab horizon from Blocks B and C north to Core 5 (Figure 7.1) might suggest that the horizon is culturally enriched with organic matter beyond that of the naturally occurring organic carbon of Buried Soil 1. Concentrations of cultural material are less in Block D than Blocks B and C. However, comparable excavations have yet to be conducted in the vicinity of Core 5. Phosphorus is highly responsive to human use of an area, increasing with increasing activities (Eidt 1977, 1985). Total phosphorus content of the 3Ab horizon increases with depth in both Block B (Figure 7.7) and Core 2 (Figure 7.8), covarying with organic carbon content. Available phosphorus varies slightly, but if there is a trend it may be to decrease slightly with depth. This tends to support the case for a cultural signal in the organic carbon profile, but in Block B, phosphorus continues to increase below the 3Ab horizon where concentrations of artifacts are less. This doesn't necessarily reflect lesser cultural impacts below the 3Ab horizon, but it might reflect differing human activities. There also is an apparent relationship between the amount of fine-grained alluvium and phosphorus content. Nevertheless, the greatest concentrations of phosphorus throughout the entire profile are associated with the lower 3Ab and upper 3Btb horizons (Figures 7.7 and 7.8). In sum, there is evidence to implicate all three factors in the distribution of the organic carbon content in the 3Ab horizon.

Considering the degree of pedogenic alteration, there is enticing evidence for stratification of the upper part of the early Rodgers Shelter submember besides the overall trend in radiocarbon ages and upward-fining sequence. There is clearly a distinct Late Paleoindian cultural deposit associated with a distinguishable sedimentary unit. Debris concentrations calculated in Chapter 8 indicate a peak in the vicinity of about 330 to 333 cm below ground surface, placing it in the upper Bt horizons and about 10 cm below the aforementioned stratigraphic discontinuity near the top of the early submember. However, there are minor secondary peaks in total and available phosphorus, and in one case organic carbon (Block B), about 2 to 3 cm below the peak in artifactual material assigned to the Middle Paleoindian component. These subtle differences could mark the Early Paleoindian cultural deposit and suggests a stratigraphic separation between the Middle and Early Paleoindian deposits.

The degree of integrity of cultural deposits likely varies through the early Rodgers Shelter submember with depositional environment. Geomorphic processes in the middle to upper point-bar environment and incipient floodplain environment, represented by the basal sheetflood facies, would have been more likely to redistribute horizontally finer pieces of pre–Early Paleoindian cultural debris because of comparatively greater current velocities. In contrast, Middle and Late Paleoindian cultural deposits associated with a better established and higher floodplain, represented by later increments of floodplain overbank sheetflood facies, would have been less likely to be redistributed because of comparatively lower current velocities

at increasingly infrequent intervals as the floodplain aggraded. There are insufficient concentrations of possible pre–Early Paleoindian cultural material to test this comparison with available Early to Late Paleoindian data from Blocks B and C. However, there are areas along the T1c stream bank where future excavations could reveal Paleoindian debris spanning the entire suite of these depositional environments.

There are ample lines of cultural evidence to suggest a large degree of integrity of Early through Late Paleoindian deposits (see Chapter 8) and support the presence of a distinct sedimentary deposit associated with Late Paleoindian material. These include, but are not limited to, the lack of imbrication of even small flakes, the limited vertical range for refit objects, intact preservation of small piles of knapping debris, and the continuity of thin manuport gravel lenses.

Postdepositional pedogenic alteration of sediments and cultural deposits was not severe enough to disturb significantly the aforementioned evidence. However, the less-than-ideal distribution of radiocarbon ages with depth, particularly near the top of the 3Bt horizons (Figure 7.12), suggests bioturbation was sufficient enough to at least cause some vertical movement of very fine charcoal fragments. Although some of the dated radiocarbon samples may have been vertically displaced, the overall trend with depth and, with few exceptions, the general correspondence with expected ages of diagnostic artifacts from cultural deposits, suggest that most either were not displaced or were not displaced a significant vertical distance. With certainty, the overall stratigraphy of the early submember is intact.

Middle Submember

The T1b paleogeomorphic surface, the underlying middle Rodgers Shelter submember, and associated Buried Soil 2 were identified in the cutbank, all subsurface excavations, and all cores except Core 4 northwest of the site (Figures 7.3–7.8). In the cutbank, the 2Ab horizon of Buried Soil 2 could be traced southwestward, beyond the limit of the 3Ab horizon of Buried Soil 1, to just south of Block A (Figure 7.3). Cutting across the southeast corner of Block A, the 2Ab horizon was encountered striking nearly north-south and dipping to the west. It was also encountered in Cores 17 and 18 located north-northeast of Block A. Along Transect A west of Core 10, the T1b surface has an apparent gentle dip to the west (Figures 7.4 and 7.6). At the western end of Transect A, the T1b surface exhibits a steeper slope representing a former stream bank (Figure 7.1). To the east, additional stratigraphic complexities are suggested by the bifurcation of Buried Soil 2 into two distinct sola in Core 14 (Figure 7.4). To date, it appears that most of the T1b surface exhibits less than 30 cm of relief in the site vicinity, excluding the stream bank. There is a local paleotopographic high in the vicinity of Core 10 and a local paleotopographic low in the vicinity of Core 6. Currently there is not enough paleotopographic information to determine the origin of these anomalies.

There are two stratigraphic sequences associated with the middle submember because of differing paleolandscapes upon which it was deposited. The middle submember is relatively thick and exhibits the complete sequence of meandering-stream facies where it overlies paleochannels associated with the T1c stream bank (Figures 7.4 and 7.6). The floodplain overbank sheetflood facies ranges up to about 5.3 m thick where it fills paleochannels, typically ranges between about 3.9 and 4.4 m thick, and decreases to less than 2.75 m thick below the former T1b stream bank. The middle submember is relatively thin (between about 1.9 and 2.65 m thick) and exhibits only the floodplain sheetflood overbank facies where it occurs as a veneer deposit overlying the T1c surface. Deposition of the middle submember effectively eliminated the paleotopography associated with the preceding T1c landscape, including paleochannels.

Excavation Blocks B, C, and D are located where the middle submember is relatively thin. Here, it consists of about 2.05 m of fairly uniform silty clay loam (Figures 7.7 and 7.8). The upward-fining sequence exhibited in the underlying early submember continues in about the lowest 50 cm of the middle submember. Sand content drops to almost nil. There is a slight coarsening in about the uppermost 75 cm as sand and coarse and medium silt content increases. The silty clay loam is dark yellowish brown (10YR 3/4, 3.5/4, 4/4) to dark brown (7.5YR 4/4). It probably was originally bedded or laminated parallel or subparallel to the T1b surface. Subsequent evolution of Buried Soil 2 and the surface soil destroyed field evidence of the primary sedimentary structures. Soil features interpreted as remnants of burned tree stumps or root systems are common. Dispersed fine charcoal is present throughout. Where the middle submember

is thick, it largely consists of silty clay loam, and typically there is a light silty clay loam basal increment.

The silty clay loam is interpreted as overbank sheetflood facies. Whether the T1c surface and its successors continued to function as a (high) floodplain during accumulation of the middle submember or functioned as a low terrace has yet to be determined. East of the T1c former stream bank, relatively thin silty clay loam sheetflood facies overlie the T1c surface forming a terrace veneer (Brakenridge 1984; Kozarski and Rotnicki 1977). West of the T1c former stream bank, thick sheetflood facies overlie clay loam to sandy loam and loamy sand that make up the middle to upper point-bar facies. At slightly lower elevations, gravely sand is interpreted as lower point-bar facies. Gravel, gravely sand, and sand at still slightly lower elevations, below the thickest increments of overbank sheetflood facies, are interpreted as channel and channel-bar facies. Based on available cores, early indications are there was little difference in elevation of point-bar tops during aggradation of the early and middle submembers. If there was a difference, the middle submember point-bar tops might have been slightly lower.

Where relatively thin, the entire increment of middle submember terrace veneer is pedogenically altered by Buried Soil 2 (Figures 7.3 to 7.8). The T1b surface is the top of this buried soil. Buried Soil 2 most commonly has a 2Ab(Bt3)–2Btb profile. Occasionally, such as in the block areas, there is a 2Ab(Bt3)–2ABtb–2Btb profile. The lower Bt horizons of the surface soil are welded onto the underlying paleosol. The 2Ab and 2ABtb horizons are very dark grayish brown (10YR 3/2) to dark yellowish brown (10YR 3/4). They have few very fine oxide dots and spheres, moderate fine to medium prismatic breaking to subangular and angular blocky structure, continuous thin clay coats on ped faces and lining pores, discontinuous thin silt coats on ped faces and interiors, and firm consistence. Collectively, these horizons form a slightly overthickened A horizon reflecting cumulic soil upbuilding (Figures 7.7 and 7.8). Silt and clay coats are some of the youngest features of these horizons and are related to welding of the overlying soil.

The 2Btb horizons are dark yellowish brown (10YR 3/4, 4/4). Fine oxide spheres decrease in frequency with depth. The horizons have a silty clay loam texture, moderate to strong medium and coarse prismatic structure, continuous thin clay coats on ped faces and common to continuous thin clay coats lining pores, common to few discontinuous thin to moderately thick silt coats, and a very firm to firm consistence.

In Core 2, there is a low clay bulge accompanying the 2Btb1 through 2Btb3 horizons (Figure 7.8). Organic carbon increases throughout the 2Ab(Bt3) and 2ABtb horizons from 0.49% to 0.56% (Figure 7.8). Peaking just below the 2ABtb horizon, it decreases through the 2Btb3 horizon to level off at about 0.40%. Total phosphorus in the 2Ab(Bt3) and 2ABb horizons decreases from 454 to 408 ppm, then overall increases gradually with depth. Highest concentrations in the profile occur in the basal 50 cm where they are about 20 ppm less than the highest concentrations in the profile in the upper part of the underlying T1c solum. Available phosphorus concentration remains fairly stable through the 2Ab(Bt3) and 2ABb horizons, then decreases slightly in the middle 2Btb horizons, and finally increases steadily to a small peak at 31 ppm in the 2Btb5 horizon at the base of the middle submember. Overall clay mineralogy varies little, but there is a slightly lower percentage of expandibles than in the underlying early submember. The HSR overall increases gradually with depth but has a slight peak in the lower 2Btb horizons. The DI ratio decreases slightly through the upper part of the solum, then increases slightly in the lower part. The entire profile is noncalcareous and mildly acidic. The pH decreases slightly in the middle part of the submember.

Buried Soil 2 in Block B also exhibits a low clay bulge similar to that in Core 2 (Figure 7.7). In contrast to the core, there is a slight increase in organic carbon content at the base of the middle submember in Block B. Phosphorus concentrations in Block B are similar to those exhibited in Core 2. The decrease in pH in the middle of the member is more pronounced in Block B.

Cultural Stratigraphy. Controlled excavations in the middle Rodgers Shelter submember where it is a relatively thin terrace veneer were limited. Even so, enough artifacts were recovered to indicate the middle submember contains Early, Middle, and early Late Archaic cultural deposits. In the vicinity of Blocks B and C, Early Archaic artifacts were recovered from about the lower half of overbank sheetflood facies of the middle submember. The cultural deposit is modified by lower 2Btb horizons of Buried Soil 2. Two Early Archaic components were recognized, an early Early Archaic and

late Early Archaic (see Chapter 8). The former extends from about 240 cm below surface to at or near the base of the middle submember at a depth of about 285 cm. The latter occurs at about 180 to 240 cm below surface.

Deposition of Middle Archaic artifacts is correlated with the lower increments of the upper half of overbank sheetflood facies of the middle submember. The Middle Archaic deposit is modified by 2Btb horizons of Buried Soil 2. The Middle Archaic deposit is estimated to extend from about 130 to 180 cm below ground surface.

Early Late Archaic artifacts were recovered from the youngest increments of overbank sheetflood facies. The stratigraphically most distinct occurrence is located where a Smith-Etley component is associated with the T1b surface (the youngest increment of the middle submember) and the 2Ab(Bt3) horizon of Buried Soil 2 in the vicinity of the T1b stream bank. Diagnostic artifacts were recovered from Block A at depths of 120 and 125 cm bs, immediately below the T1b surface. A number of other contemporaneous diagnostic artifacts were recovered where the T1b surface is about 75 cm below modern ground surface and the late Rodgers Shelter submember is a relatively thin terrace veneer. In this location, artifacts from younger Late Archaic components form a palimpsest on the T1b surface and stratigraphic distinction of components is difficult, if not impossible.

Geochronology. Eight radiocarbon ages were obtained from the middle Rodgers Shelter submember (Table 7.1). The limited number of samples reflects the emphasis during testing to reach, excavate, and date the Paleoindian deposits; it does not reflect a paucity of charcoal. Four samples consisted of wood charcoal, two of soil humates, one of carbonized bark, and one of carbonized hickory nut shell. Two were sufficiently large to use the standard radiocarbon technique, and six were assayed using the AMS technique. Charcoal from a burn feature at the basal contact of the middle submember with the underlying early submember yielded an age of 9190 ± 90 B.P. (Beta-112982). A tiny charcoal fragment collected 251 cm below ground surface in association with Early Archaic debris yielded an age of 9525 ± 65 B.P. (AA-27479). A second tiny charcoal fragment in association with Early Archaic debris was collected from 190–192 cm below ground surface; it yielded an age of 8190 ± 60 B.P. (AA-29019). The fourth sample consists of charcoal from the cutbank collected from where the middle submember is thick. It yielded an age of 8110 ± 140 B.P. (Beta-117781).

Two AMS radiocarbon samples were collected from the youngest increment of the middle submember where it is modified by the 2Ab(Bt3) of Buried Soil 2. The samples were collected from the shoulder slope of the former stream bank and were associated with early Late Archaic diagnostic artifacts. Sample AA-29020 consists of carbonized bark and was collected from the lower part of the 2Ab(Bt3) horizon at a depth of 160 cm below ground surface. It yielded an age of 4130 ± 45 B.P. The other sample, AA-29018, consists of carbonized hickory nut shell collected from the top of the 2Ab(Bt3) horizon at a depth of 120 to 130 cm below ground surface. It yielded a similar age of 4125 ± 45 B.P. Bulk soil samples 10 cm thick were collected from the top and bottom of the 2Ab(Bt3) horizon in the south wall of Block B. The sample from the top was collected 90 to 100 cm below ground surface. It yielded an age of 4497 ± 57 B.P. (Tx-9328). The bottom sample, collected 120 to 130 cm below ground surface, yielded an age of 5158 ± 54 B.P. (Tx-9330). They are both several centuries older than the ages determined on charcoal from the same horizon. This suggests slight contamination of the soil humate samples with older carbon.

Late Submember

The late Rodgers Shelter submember is the surficial unit underlying the T1a surface. It was identified in all excavations, cores, and the cutbank (Figures 7.3–7.8). The T1a surface is modified by oriented chutes scoured by overbank floodwaters. As with the middle submember, the late submember exhibits two stratigraphic sequences because of differing paleolandscapes upon which it was deposited. Where it overlies paleochannels associated with the T1b stream bank, essentially west of the T1b stream bank, it is relatively thick and exhibits a complete sequence of meandering-stream facies. It is relatively thin where it occurs as a terrace-veneer deposit on the T1b surface. In this position, it is generally less than a meter thick. Only the sheetflood facies is present in this position.

Where the late Rodgers Shelter submember occurs as a terrace veneer, it consists of up to about 95 cm of silt loam and silty clay loam. The texture is slightly coarser than that of the underlying middle submember (Figures 7.7 and 7.8). Colors range from very dark grayish brown (10YR 3/2) to brown

(10YR 4/3). Original sedimentary structures, probably horizontal laminae and thin beds, were obliterated by pedogenesis of the surface soil. Burned tree stump or root features are common, particularly immediately below the plow zone where the late submember is thick. Dispersed fine charcoal is sparse to common.

The fine-grained terrace veneer represents overbank sheetflood facies. It is likely that the T1b surface functioned as a terrace at the time it was buried. When coupled with the fact that the overbank sheetflood facies is slightly coarser than the underlying deposit, it minimally suggests an increase in flood magnitude.

The entire terrace veneer is pedogenically altered by the surface soil associated with the T1a terrace (Figures 7.3 and 7.8). The surface soil exhibits some variation. It exhibits either an Ap–(A)–AB–Bt1–Bt2 profile or an Ap–Bt/E1–Bt/E2–Bt1–Bt2 profile. The soil profile is welded onto Buried Soil 2, extending well below the T1b surface. The Ap and A horizons are very dark grayish brown (10YR 3/2). They have silt loam texture, weak to moderate medium subangular blocky structure parting to fine subangular and angular blocky structure, and friable consistence.

The Bt horizons are brown (10YR 3.5/3, 4/3) heavy silt loam to light silty clay loam. They have few very fine oxide dots and spheres, moderate medium and coarse parting to fine and medium angular blocky to subangular blocky structure that tends to prismatic in lower horizons, continuous thin clay coats on ped faces and lining few pores, and firm consistence. In many cases, the upper Bt horizons have few to common discontinuous thin silt coats on ped faces, within ped interiors, and lining root pores and channels. Where this occurs, Bt/E horizons are noted. Often, the frequency and thickness of silt coats increases with depth.

Within the late submember, there is a coarsening-upward trend (Figures 7.7 and 7.8). Organic carbon decreases slightly with depth, and phosphorus and pH increase sharply with depth. There is little change in the clay mineralogy from the middle to late submember, and the overall decreasing-upward trend in the HSR continues.

Cultural Stratigraphy. Stripping of the plow zone and controlled excavations in the late Rodgers Shelter submember indicate that several cultural components are represented where it occurs as a terrace veneer: early, middle, and late Late Archaic; undifferentiated Woodland; Late Woodland/Early Mississippian; and Middle/Late Mississippian. Early Late Archaic debris and artifacts were recovered from the contact area of the middle and late submembers. At least some of the debris was clearly from basal increments of the late submember. This indicates that the early Late Archaic occupation spanned at least part of development of Buried Soil 2 through early phases of late submember sedimentation. A 30-cm-thick middle Late Archaic midden was encountered in thick late-submember overbank sheetflood deposits at a depth of about 230 to 260 cm below ground surface in Block A. Although several late Late Archaic artifacts were recovered, only one was from an undisturbed stratigraphic context. It was located in thick late submember deposits at a depth of 150 cm below ground surface.

A small quantity of undifferentiated Woodland debris was recovered from very limited excavations. Diagnostic artifacts were recovered only from the plow zone or its base, mostly where the late submember is thin. Where thick, they probably occur about 40 to 100 cm below ground surface, or just below the surface soil A or AB horizon. Where thin, they occur about 25 to 60 cm below ground surface. This indicates the bulk of the late-submember aggradation occurred prior to the Middle or Late Woodland periods (see Chapter 8).

Numerous Late Woodland/Early Mississippian diagnostic artifacts were recovered from the plow zone and at the base of the plow zone. This indicates the T1a surface essentially had stabilized by this time. Finally, one feature and one artifact indicate at least an ephemeral Middle/Late Mississippian occupation. A point was identified in the plow zone, and the feature appeared at the base of the plow zone.

Geochronology. Three radiocarbon ages are associated with the late Rodgers Shelter submember. A radiocarbon age of 760 ± 70 B.P. (Beta-112983) was obtained from the Middle/Late Mississippian feature encountered at the base of the plow zone. Two radiocarbon ages were obtained from the middle Late Archaic midden. Sample Beta-112984 consists of carbonized wood and nut shell and was collected from the middle of the midden. It yielded an age of 4040 ± 100 B.P. A second sample consisting of carbonized nut shell from the lower part of the midden yielded an age of 4020 ± 80 B.P. (Beta-109009).

Pippins Cemetery Member

The Pippins Cemetery member is laterally inset into the Rodgers Shelter member and underlies the T0b surface (Figure 7.3). It consists of up to 4.5 m of very dark grayish brown (10YR 3/2) to dark gray (10YR 4/1) silt loam to sandy loam that is pedogenically altered due to development of the surface soil. No archaeological excavations were conducted within this member, and cultural debris was not present on the T0b surface. Fine to coarse charcoal fragments are common. Sandy loam conformably overlies sandy gravel. This facies contact occurs about 100 cm below the top elevation of point-bar sand and gravel in the Rodgers Shelter member.

Sedimentologically, the Pippins Cemetery member exhibits the same facies as the Rodgers Shelter member and records lateral migration of a meandering stream. Finer-textured, horizontally bedded but pedogenically altered sediment was deposited as sheetflood overbank deposits on former floodplain surfaces. The Pippins Cemetery member overbank sheetflood facies contains more organic carbon than the Rodgers Shelter member, as indicated by the lower value and chroma of soil colors. The sand to sandy loam represents middle to upper point-bar deposits created by lateral accretion as the Sac River channel migrated through the area.

Cultural Stratigraphy

No excavations were conducted in the Pippins Cemetery member, and no debris was seen in the cutbank on the south side of the site. However, this member could contain buried late-prehistoric artifacts.

Geochronology

One radiocarbon age was obtained from the Pippins Cemetery member. A sample was taken from an uncarbonized log protruding from the cutbank at low-water level (Figure 7.3). The log was in unoxidized, fine-texture paleochannel fill. It yielded an age of 490 ± 50 B.P. (Beta-117783) (Table 7.1).

STABLE CARBON ISOTOPES

Stable carbon isotope analysis of organic carbon in soils has been successfully used in many paleoenvironmental studies (e.g., Ambrose and Sikes 1991; Fredlund and Tieszen 1997; Guillet et al. 1988; Kelly et al. 1991, 1993; Krishnamurthy et al. 1982; Nordt 1993; Nordt et al. 1994; Schwartz 1988; Schwartz et al. 1986). To understand the theory behind this analytical technique, the ecology of C_3 and C_4 plants must be considered. During photosynthesis, C_4 plants discriminate less against $^{13}CO_2$ than C_3 plants (O'Leary 1981; Vogel 1980). This difference in carbon isotope fractionation results in a characteristic carbon isotope ratio in plant tissue that serves as an indicator for the occurrence of C_3 and C_4 photosynthesis (Nordt 1993:52). Boutton (1991a) demonstrated that the $\delta^{13}C$ values of C_3 plant species range from -32 to -20‰, with a mean of -27‰, whereas the $\delta^{13}C$ values of C_4 plant species range from -17 to -9‰, with a mean of -13‰. Thus, C_3 and C_4 plant species have distinct, non-overlapping $\delta^{13}C$ values and differ from each other by approximately 14‰ (Boutton 1991b).

Nearly all trees, shrubs, forbs, and cool-season grasses are C_3 species. Hence forests and most other temperate plant communities are dominated by C_3 species. Plants with the C_4 photosynthetic pathway are common in warm, semiarid environments with high light intensity, such as grasslands, savannas, deserts, and salt marshes. Studies have shown that both the proportion of C_4 species and the proportion of C_4 biomass in a given plant community are strongly related to environmental temperature (Boutton et al. 1980; Terri and Stowe 1976; Tieszen et al. 1979). These relationships are invaluable in paleoecological studies when the relative proportions of C_3 vs. C_4 species can be reconstructed (Nordt et al. 1994).

There is little change in the carbon isotopic composition of plant litter as it decomposes and is incorporated into the soil organic matter (Melillo et al. 1989; Nadelhoffer and Fry 1988). Consequently, the isotopic composition of soil organic matter reflects the dominant species (C_3 vs. C_4) in the plant community that contributed the organic matter (Dzurec et al. 1985; Nadelhoffer and Fry 1988; Stout and Rafter 1978). The stable carbon isotopic composition of soil organic matter in surface and buried soils may, therefore, be used to infer vegetation change (Hendy et al. 1972; Krishnamurthy et al. 1982; Nordt et al. 1994). Going one step further, the stable carbon isotopic values may be used to reconstruct climate.

Organic carbon in the late Quaternary alluvial deposits and soils at the Big Eddy site are derived

primarily from two inherited sources and one pedogenic source. One inherited source is the erosion and redeposition of organic-rich material derived from the A horizons of upland soils. Because the Sac River basin encompasses an area that is bioclimatically and geologically uniform, organic carbon from upland soils will reflect one set of paleoenvironmental conditions and not an average of several climatic or vegetational zones as is the case with larger drainage basins. This inherited organic source is, therefore, desirable for interpreting past vegetation and climatic shifts (Nordt et al. 1994).

A second inherited source of organic carbon is older alluvium that has been eroded and redeposited. This source is undesirable, but it should not significantly bias $\delta^{13}C$ interpretations because organic carbon contents of the older alluvium are low.

During periods of floodplain stability, organic carbon derived from pedogenic processes is superimposed on, and mixed with, the inherited organic carbon fraction (Nordt et al. 1994). With the establishment of vegetation on floodplains, decaying organic matter will accumulate in the soil and yield $\delta^{13}C$ signatures that are in equilibrium with ambient vegetation conditions. This source of organic carbon is desirable for reconstructing late Quaternary vegetation and climate (Nordt et al. 1994).

The $\delta^{13}C$ values determined on organic carbon from soils at the Big Eddy site ranged from -16.0 to -25.9‰ (Table 7.2). These data reveal significant shifts in the ratio of C_3 to C_4 plant biomass production during the past 13,000 years. It is likely that the temporal changes in vegetation were in response to regional climatic change.

The isotopic data suggest that at around 12,700 B.P., a C_3 plant community dominated the local ecosystem (Figure 7.13). This interpretation is based on a $\delta^{13}C$ value of -22.9‰ from the 4BCb1 horizon (Figure 7.13). Soon after ca. 12,700 B.P., and continuing to sometime between ca. 10,000 and 9500, there was a gradual shift to a mixed assemblage of C_3 and C_4 biomass. The $\delta^{13}C$ values range from -21.1 to -17.3‰ during this period, with the highest values in the 3Ab(2Btb6) horizon (Figure 7.13). This shift most likely represents a slight drying and warming trend. However, the return to lower $\delta^{13}C$ values in the 2Btb5, 2Btb4, and lower 2Btb3 horizons probably reflects an increase in effective moisture between ca. 9500 and 8200 B.P. (Figure 7.13).

The upper 2 m of the soil profile at the Big Eddy site displays two distinctive $\delta^{13}C$ trends with depth (Figure 7.13). The first trend occurs from the upper half of the 2Btb3 horizon to the top of the 2Ab(Bt3) horizon, where the $\delta^{13}C$ values indicate a significant increase in the contribution of C_4 plants (Figure 7.13). The radiocarbon ages suggest that sediment in this portion of the profile accumulated between about 8200 and 4100 B.P. The maximum abundance of C_4 plants is associated with the 2Ab(Bt3) horizon, which gained most of its organic carbon between ca. 5100 and 4100 B.P. (Figure 7.13). Stable carbon isotope samples from the 2Ab(Bt3) horizon yielded $\delta^{13}C$ values ranging between -16.0 and -16.8‰. In addition, organic carbon from bulk soil samples collected from the upper and lower 10 cm of the 2Ab (Bt3) horizon for radiocarbon dating of humates yielded $\delta^{13}C$ values of -16.6 and -15.6‰, respectively. Together, these data indicate relatively warm and dry conditions between ca. 5100 and 4100 B.P.

The sediment above the 2Ab(Bt3) horizon accumulated soon after ca. 4100 B.P. This zone shows the second $\delta^{13}C$ trend, where there is an abrupt and fairly steady increase in the contribution of C_3 plants from the bottom of the Bt2 horizon to the top of the Ap horizon (Figure 7.13). Most of the $\delta^{13}C$ values range between -18.7 and -22.3‰, and they reach a low of -25.9‰ in the plow zone. This trend indicates that a mixed C_3–C_4 plant community, and more mesic conditions, had reemerged soon after 4100 B.P. and persisted up to modern times. The low $\delta^{13}C$ value from the plow zone probably reflects the modern C_3 plant community (mostly trees and shrubs) that dominates the landscape as a result of fire suppression during modern times.

Regional Correlation of Late Quaternary Paleoclimatic Data

The paleoenvironmental reconstruction inferred from the results of the stable carbon isotope analyses in this study generally agrees with previous late Quaternary climatic interpretations for the western Ozarks and nearby areas of the southern Plains. The isotopic data for the Big Eddy site suggest that a C_3 plant community dominated by trees existed in the region at ca. 12,700 B.P. This interpretation is supported by palynological and paleontological data from Trolinger and Boney springs in the lower Pomme de Terre River valley. These data indicate that spruce-dominated forests existed in the region until at least 13,500 B.P. (King 1973; King and Lindsay 1976:76; Saunders 1988). Based on the

Table 7.2. $\delta^{13}C$ values of Soils in Blocks B and C.

Soil Horizon	Depth (cm)	$\delta^{13}C^a$
Ap	0–02	-25.9
Ap	10–12	-22.3
AB	20–22	-21.5
AB	30–32	-21.5
Bt1	40–42	-21.9
Bt1	50–52	-21.5
Bt1	60–62	-20.7
Bt2	70–72	-19.8
Bt2	80–82	-18.9
2Ab(Bt3)[b]	90–92	-18.7
2Ab(Bt3)[b]	100–102	-16.2
2Ab(Bt3)[b]	110–112	-16.5
2Ab(Bt3)[b]	120–122	-16.8
2Ab(Bt3)[b]	130–132	-16.0
2ABtb	140–142	-17.1
2Btb1	150–152	-18.0
2Btb1	160–162	-18.0
2Btb2	170–172	-18.2
2Btb2	180–182	-18.9
2Btb3	190–192	-18.4
2Btb3	200–202	-20.4
2Btb4	210–212	-20.3
2Btb4	220–222	-20.3
2Btb4	230–232	-21.0
2Btb4	240–242	-20.7
2Btb5	250–252	-20.3
2Btb5	257–259	-20.5
2Btb5	260–262	-19.4
2Btb5	265–267	-20.1
2Btb5	270–272	-19.8
2Btb5	280–282	-19.7
3Ab(2Btb6)[b]	290–292	-17.4
3Ab(2Btb6)[b]	297–299	-17.3
3Ab(2Btb6)[b]	305–307	-17.6
3Ab (2Btb6)[b]	313–315	-18.6
3Ab(2Btb6)[b]	321–323	-19.3
3Btb1	330–332	-20.3
3Btb1	338–340	-20.7
3Btb1	346–348	-20.5
3Btb2	354–356	-20.8
3Btb2	363–365	-21.2
3Btb2	371–373	-21.2
3Btb2	379–381	-21.6
4BCb1	388–390	-21.1
4BCb1	397-399	-22.9

[a] All reported in units of ‰ relative to standard PDB.

[b] Welded soil.

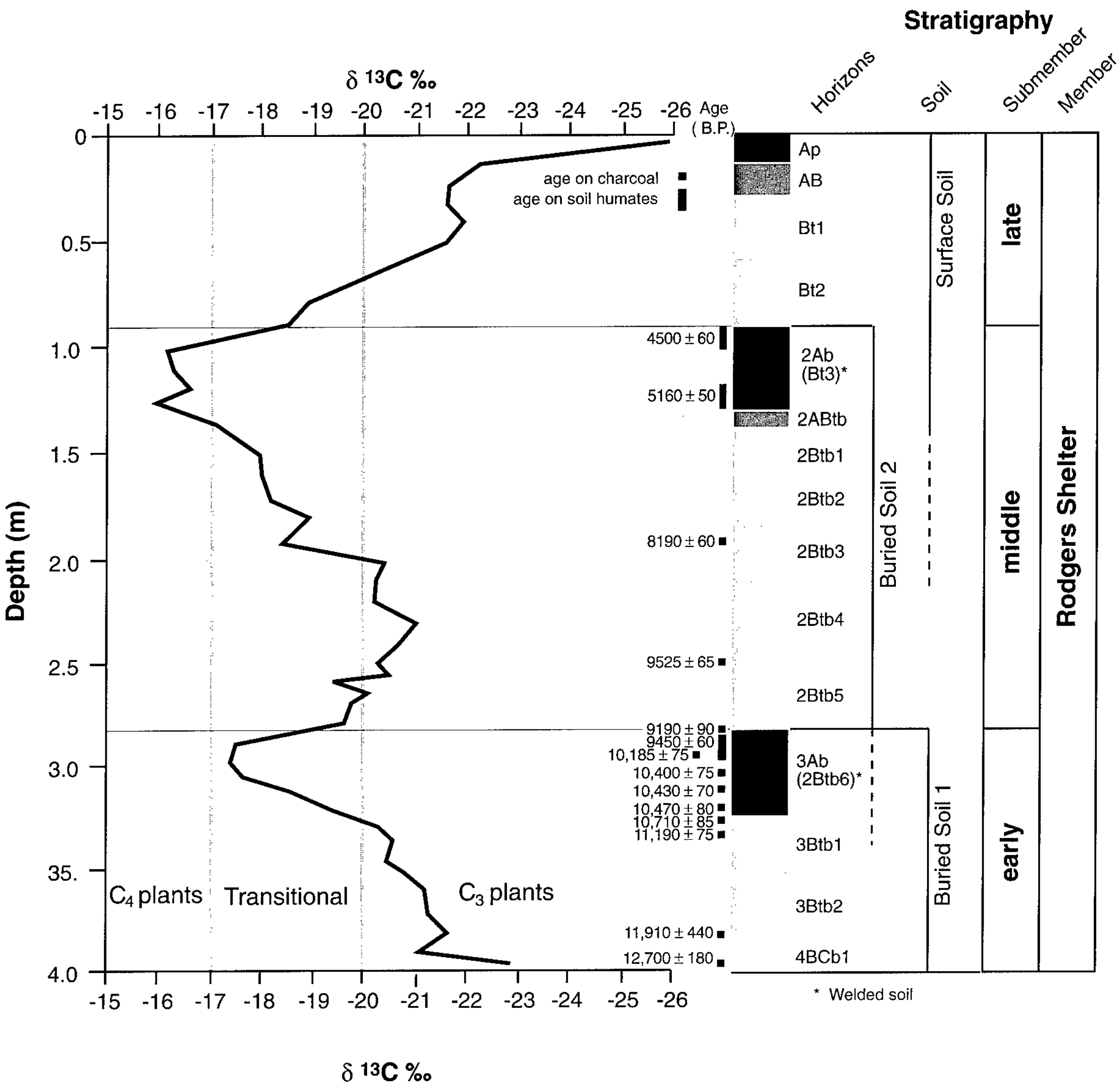


Figure 7.13. $\partial^{13}C$ values verses depth and stratigraphy in Blocks B and C.

record from Boney Spring, King (1988:156) suggests that by "13,500, spruce had begun to decline and cool temperate hardwoods began to increase in western Missouri." Extrapolating from Gruger's (1973) pollen record at Muscotah Marsh in northeastern Kansas, King and Lindsay (1976) suggest that the Ozark spruce forest did not disappear until about 12,000 years ago.

The Pleistocene-Holocene boundary is often shown as a rather abrupt change in most pollen diagrams (Broecker et al. 1960; Davis 1976; Gruger 1973). However, pollen records for the western Ozarks do not span this period; hence the nature of the Pleistocene-Holocene transition is unknown for the region. The isotope data for the Big Eddy site suggest that there was a gradual shift to a mixed assemblage of C_3 and C_4 biomass from ca. 12,700 B.P. to ca. 9500 B.P.

This shift implies a trend towards drier and warmer conditions and concomitant expansion of prairies during the Pleistocene-Holocene transition. Although corroborative data are unavailable

for the region, pollen data from sites in the Midwest and eastern Plains show high percentages of herb or nonarboreal pollen, indicative of the expansion of prairie, during the interval of 11,000–9000 B.P. (Bernabo and Webb 1977; Davis 1965; Gruger 1973; McAndrews 1966, 1967; Wilkins et al. 1991; Wright 1976). A similar transition has also been reported for several areas of the southern Great Plains. For example, in a study of stable organic carbon isotopes from soils and sediments in central Texas, Nordt et al. (1994) demonstrated that the abundance of C_4 species increased to about 65–75% of the total plant community between ca. 11,000 and 8000 B.P. They suggested that the shift to warmer and drier conditions was relatively slow during the early Holocene and did not reach a peak until ca. 6000–5000 B.P.

The results of other studies also point to an early Holocene climatic transition between cooler and wetter late Pleistocene and drier and warmer early Holocene conditions. During this time, streams in northwest Texas were changing from perennial flow to isolated lacustrine ponds and intermittent flow that was accompanied by increasing mean annual temperature (Holliday 1985a, 1995; Holliday et al. 1983; Johnson 1987; Pierce 1987). Holliday (1995) noted that water ceased to flow in the draws of the southern High Plains by early Holocene times. He demonstrated that the timing of this shift varies from as early as 11,000 B.P. to as late as 9000 B.P. By ca. 9000 B.P., much of the deposition in the draws is in the form of marl with some eolian sediment. This deposition suggests a decline in spring discharge and may indicate a rise in temperature (Holliday 1995:307).

In contrast to the evidence cited above, stable oxygen and carbon isotopes from lacustrine and soil carbonates at the Aubrey site in north-central Texas indicate that relatively moist conditions persisted until ca. 7500 B.P. (Ferring 1995; Humphrey and Ferring 1994). However, the $\delta^{13}C$ values determined on organic carbon show a mixed assemblage of C_3 and C_4 plants at Aubrey between ca. 10,000 and 7500 B.P., with C_4 biomass production gradually increasing during this period.

The isotope data for the Big Eddy site suggest a slight increase in effective moisture between ca. 9500 and 8200 B.P. Although a mixed assemblage of C_3 and C_4 biomass persisted during this period, it is likely that forests expanded at the expense of prairies. Such fluctuations in vegetation should be expected along the forest-prairie ecotone in western Missouri. The results of the isotope analyses provide compelling evidence for a middle Holocene drying episode (i.e., Altithermal) in southwestern Missouri, as interpreted from the dramatic shift in the abundance of C_4 species during this period. Prairie expansion appears to have been underway by ca. 8200 B.P. and reached its maximum extent around 4500 B.P. Our findings are in general agreement with middle Holocene climatic trends observed for the southern High Plains. For example, northwest Texas was experiencing conditions of maximum temperatures, minimum precipitation, and eolian activity between ca. 6000 and 4500 B.P. (Holliday et al. 1983; Holliday 1985a, 1985b, 1989, 1995; Pierce 1987). Based on enriched $\delta^{13}C$ values in soil carbonates from north-central Texas, Humphrey and Ferring (1994) also show a middle Holocene xeric episode. In some studies, paleobotanical evidence suggests that the Prairie Peninsula reached its maximum extent around 7000 B.P. (Delcourt and Delcourt 1981, 1984; King 1977; Wright 1968), encroaching as far south as Kentucky and Tennessee, as far east as northwestern Pennsylvania, and as far north as central Wisconsin and Michigan.

The isotope record for Big Eddy suggests that there has been gradual expansion of forests in western Missouri during the late Holocene (4000 B.P. to the present). This record implies a shift back to cooler and/or wetter conditions shortly after 4100 B.P. Many paleoenvironmental studies have documented a transition to more mesic conditions around 4000 B.P. King (1977) suggested that the late Holocene climate in western Missouri has been "a climatic regime of its own, wetter than the dry period that preceded it, but not as wet as the early Holocene." The resumption of spring discharge at several localities in the lower Pomme de Terre River valley during the late Holocene probably reflects a rebound in available moisture. There is abundant evidence from the southern High Plains indicating that conditions much like the present were in place soon after 5000 B.P., with brief episodes of increased aridity during the past 2,000 years (Holliday et al. 1983; Holliday 1985a; Humphrey and Ferring 1994; Pierce 1987).

Summary

Based on the $\delta^{13}C$ values from the organic matter of alluvial sediment and soils at the Big Eddy site, C_3 plants dominated the landscape of south-

western Missouri during the terminal Pleistocene (ca. 12,700 B.P.). This late Pleistocene plant community probably reflected climatic conditions that were cooler, wetter, or both, relative to any subsequent period during the Holocene.

Soon after ca. 12,700 B.P., and continuing to ca. sometime between 9500 and 10,000 B.P., there was a gradual shift to a mixed assemblage of C_3 and C_4 biomass. The vegetation and climate during this period were transitional between cooler, wetter late Pleistocene and warmer, drier Holocene climates. Between ca. 9400 and 8200 B.P., however, the $\delta^{13}C$ values decrease slightly, suggesting an increase in C_3 biomass production that is related to greater effective moisture.

The isotope data suggest that C_4 biomass production began to increase around 8100 B.P. and reached a maximum between 5000 and 4500 B.P. This is interpreted as a time of maximum drying and warming (Altithermal) that led to expansion of open grasslands on uplands, terraces, and floodplains. Soon after 4100 B.P., there is a shift towards increased C_4 biomass production. This trend continues today. Hence, more mesic climatic conditions had emerged by the early late Holocene and continued into modern times.

LANDSCAPE EVOLUTION

Stratigraphic, temporal, and paleoenvironmental data from preliminary investigations provide the basis for outlining provisional phases of landscape evolution in the vicinity of the Big Eddy site in the Sac River valley (Table 7.3). During the latter part of the late Wisconsinan, stream levels were similar to today, although floodplain levels were up to 3 m lower. At the Big Eddy site, a pebble to cobble gravel bar was deposited prior to a shift from a braided to a meandering stream regime shortly before about 12,940 B.P. Shortly after about 12,700 B.P., C_3 plant communities gave way to a mixed assemblage of C_3 and C_4 plants, possibly due to slight drying and warming, and incipient floodplain sedimentation of the early Rodgers Shelter submember commenced. At times, flood traction currents were great enough to deposit thin gravel beds across parts of floodplain near the channel. During this time, it is possible the Big Eddy location was visited by pre–Early Paleoindian people.

Sometime between about 12,940 B.P. and 11,000 B.P., the Sac River meandered through the site area depositing a point bar. Aggradation of middle to upper point-bar sediments followed by floodplain overbank sheetflood sediments continued, apparently uninterrupted, between 11,900 and 10,450 B.P., with progressively finer sediments being deposited as the floodplain elevation increased and the channel meandered slightly away from the site. During this phase, Early and Middle Paleoindian people utilized the site. It is possible that there was a brief pause or decrease in sedimentation rates prior to aggradation of the final increment of the early submember between about 10,450 B.P. and 10,100 B.P. The addition of this final increment was relatively rapid, and accompanied by multiple Late Paleoindian occupations that probably contributed to the organic carbon content of the deposits. Following sedimentation of this bed, the floodplain stabilized temporarily. Buried Soil 1 formed on the T1c surface, and Late Paleoindian occupation may have continued into this phase. At this time, the Sac River channel was flowing immediately west and north of the site, and by implication must have been flowing between the site and the bedrock uplands to the west. By about 9500 B.P., the gradual shift to a slightly drier and warmer climate had stabilized.

After about 9500 B.P. at the latest, floodplain sheetflood sedimentation resumed and the middle Rodgers Shelter submember was deposited. On the order of 2.75 m of terrace-veneer sediments, and up to about 4.4 m of sediment over former channel positions of the previous phase, were deposited by about 4500 B.P., burying the T1c surface. Renewed aggradation initially was rapid, and the Sac River migrated westward and northward. Toward the end of this phase, the higher floodplain stabilized at the T1b level with little additional sedimentation. During the early part of this phase, the higher floodplain overlying the T1c surface was occupied by Early Archaic people. The aggrading higher floodplain surfaces continued to be a favorable location for occupation first by Middle Archaic, then by early Late Archaic people. During the initial part of this phase, from about 9450 to 8200 B.P., effective moisture increased, at first rapidly, and then more slowly. However, from about 8200 to 4500 B.P., plants communities indicative of progressively drier and warmer conditions predominated. Between about 4500 and 4100 B.P., Buried Soil 2 formed on the T1b surface. The T1b surface may have functioned as a terrace during this phase. The Sac River continued to migrate northwestward, forming new, lower floodplain surfaces. Early Late Archaic people continued to visit the site. Rela-

Table 7.3. Phases of Landscape Evolution.

Phase (RCYBP)	Events
> 12,940	A possibly braided stream deposited a pebble to cobble gravel bar and eventually transitioned to a meandering regime.
>12,940–11,900	A meander migrated through the site depositing point-bar sediments followed by incipient floodplain sedimentation. Overbank and traction currents were occasionally strong enough to move and deposit fine to medium gravel. The location possibly was visited by pre–Early Paleoindian people.
11,900–10,450	The floodplain vertically aggraded on the order of 65 cm and probably stabilized briefly at the end of the phase. The site location was visited repeatedly by Early and Middle Paleoindian people.
10,450–10,000	The floodplain continued to aggrade about an additional 40 cm. Deposition of the early submember of the Rodgers Shelter member ended. During this phase, the floodplain hosted Late Paleoindian occupations.
10,000–9500	Sometime during this interval the floodplain stabilized at the level of the T1c surface. Buried Soil 1 developed as the floodplain received only minor incremental additions. Late Paleoindian or early Early Archaic occupation may have occurred.
9500–4500	The Sac River migrated westward and northward. By about 9500 B.P., floodplain overbank sedimentation resumed, both on the former T1c floodplain and on newly forming floodplain surfaces to the west. The middle submember of the Rodgers Shelter was deposited. Renewed aggradation initially was rapid. A relatively thick veneer buried the T1c surface, with even thicker floodplain accumulations occurring to the west and north. Towards the end of this phase, the higher floodplain surface became relatively stable at the T1b level with only minor additions. During the early part of this phase, the higher floodplain overlying the T1c surface was occupied by Early Archaic people. The aggrading higher floodplain surfaces continued to be a favored locale for occupation as first Middle Archaic, then early Late Archaic people visited the site.
4500–4100	Buried Soil 2 developed from the T1b surface as the floodplain, now likely a low terrace, remained relatively stable with only minor incremental additions. Floodplain aggradation continued on lower, newly forming floodplain surfaces. The high floodplain or low terrace, including its scarp, were occupied by early Late Archaic groups.
4100–2500	The Sac River continued its westward migration. Floodplain overbank sedimentation continued on lower floodplain surfaces and resumed on the high floodplain or low terrace represented by the T1b surface, depositing the late submember of the Rodgers Shelter member. The T1b surface was buried by a relatively thin veneer of overbank sheetflood deposits. The lower portion of the terrace-veneer surface was occupied by early, middle and late Late Archaic groups with little, if any discernible, stratigraphic separation. The lower floodplain surface was occupied by a middle Late Archaic group about midway through its aggradation.
2500–1500	The surface soil associated with the T1a surface developed with little additional overbank sedimentation and aggradation where the late submember forms a veneer over the T1b surface. To the west, the T1a surface stabilized slightly later, and early in this phase underwent limited aggradation. Occupation by undifferentiated Woodland groups occurred.
1500–present	Soil development continued on the T1a surface. It was occupied by Late Woodland/Early Mississippian and Middle/Late Mississippian groups. The Sac River migrated westward or began to contract its channel size as the Pippins Cemetery member was deposited.

tively dry and warm conditions persisted between about 5100 and 4100 B.P.

Between about 4100 and 2500 B.P., floodplain sedimentation continued on lower floodplain surfaces and resumed on the high floodplain or low terrace represented by the T1b surface. The late Rodgers Shelter submember aggraded during this period, and the T1b surface was buried by less than a meter of sheetflood deposits. The Sac River continued its migration to the north and west. The terrace-veneer surface was occupied by early, middle, and late Late Archaic groups with little, if any, discernible stratigraphic separation. The lower floodplain surface was occupied by a middle Late Archaic group about midway through its aggradation. A distinct trend towards more mesic conditions began after about 4100 B.P. Between about 2500 and 1500 B.P., the surface soil associated with the T1a terrace developed with little additional overbank sedimentation. To the west, the T1a surface stabilized slightly later, and early in this phase underwent limited aggradation. The area was occupied by undifferentiated Woodland groups, and relatively mesic conditions prevailed.

From about 1500 B.P. until the present, the surface soil continued to develop on the T1a terrace. It was occupied by Late Woodland/Early Mississippian and Middle/Late Mississippian groups. The Pippins Cemetery member was deposited during this phase, although it has yet to be adequately dated. Although it still receives floodwaters, a soil has developed on the T0b surface of the Pippins Cemetery member. Mesic conditions continued during this phase.

SUMMARY

Stratified cultural deposits at the Big Eddy site are on and buried within the Rodgers Shelter member, a pedogenically altered alluvial deposit at least 5.5 m thick. The Rodgers Shelter member consists of three submembers, each exhibiting point bar and floodplain facies of meandering streams (Figure 7.14). Submembers are distinguished by intervening buried soils, subtle sedimentological differences, and the cultural deposits they contain. Overall, they record episodic aggradation in the Sac River valley.

The early Rodgers Shelter submember aggraded between >12,940 and 10,100 B.P., then stabilized with pedogenesis the predominant process between about 10,000 and 9500 B.P. Around 12,700 B.P., the area was dominated by a C_3 plant community that gradually shifted to a mixed C_3 and C_4 community representing a gradual shift to a slightly drier and warmer climate. By about 9500 B.P., this shift had stabilized.

Integrated stratigraphic, sedimentological, geochemical, archaeological, and temporal data indicate Paleoindian deposits with strong contextual integrity are stratified over a thickness of about 90 cm of upper point bar and incipient floodplain sheetflood deposits in the early Rodgers Shelter submember. Late, Middle, and Early Paleoindian cultural deposits are stratified throughout about the upper 90 cm of the 2.9+ m of alluvium in the member (Figure 7.14). The Late Paleoindian deposits are associated with the 3Ab horizon of Buried Soil 1 that developed from the T1c surface on the top of the early submember. The presence of several artifacts from a very limited area of excavation into sediments below Paleoindian cultural deposits cannot be ignored as possible pre-Clovis cultural deposits.

The middle Rodgers Shelter submember occurs as both a terrace veneer where it buries the T1c surface of the early submember and a thicker body where it fills and overlies former early submember channel positions. It comprises the bulk of Holocene valley fill and was deposited between about 9500 and 4500 B.P. (Figure 7.14). Buried Soil 2 formed between about 4500 and 4100 B.P. on the T1b surface on the top of the middle submember. In the terrace-veneer landscape position, early and late Early Archaic cultural deposits occur in basal increments of the submember, Middle Archaic cultural deposits occur in the lower increments of the upper half of the submember, and early Late Archaic cultural deposits are associated with the upper increments and 2Ab horizon of Buried Soil 2. During initial aggradation of the submember, conditions rapidly, then more slowly, became relatively cooler and/or wetter. After about 8200 B.P., conditions became progressively drier and warmer, with a relative maximum dry and warm interval between about 5100 and 4100 B.P.

Similar to the middle submember, the late Rodgers Shelter submember has two sediment sequences: a relatively thin terrace veneer where it buries the T1b surface and a thicker sequence where it fills and overlies former channel positions associated with the middle submember. The terrace veneer, typically less than a meter thick, was deposited between about 4100 and 2500 B.P. (Figure 7.14).

Today, it is in a terrace position and is modified by the surface soil. Within it, early, middle, and late Late Archaic cultural deposits are associated with the T1b surface and basal increments of the late submember. They are almost certainly a palimpsest deposit without stratigraphic resolution. Where the late submember is thick, the basal age is older. The top of a middle Late Archaic midden is at a depth of 230 cm. Undifferentiated Woodland cultural deposits occur in the plow zone or just below its base where the late submember is thin. Where thick, they probably occur at a depth of about 40 to 100 cm. Late Woodland/Early Mississippian and Middle/Late Mississippian artifacts and features also occur in the plow zone and just below its base.

The Pippins Cemetery member is inset below the Rodgers Shelter member. The top of it forms the T0b floodplain surface. It represents point bar and overbank sediments deposited from about 1500 B.P. probably until historic agricultural production was introduced into the basin. Prehistoric cultural associations remain uninvestigated. Following the introduction of modern agriculture and, more recently, installment of the Stockton Reservoir, an unnamed alluvial member has begun to aggrade on low floodplain surfaces and point bars.

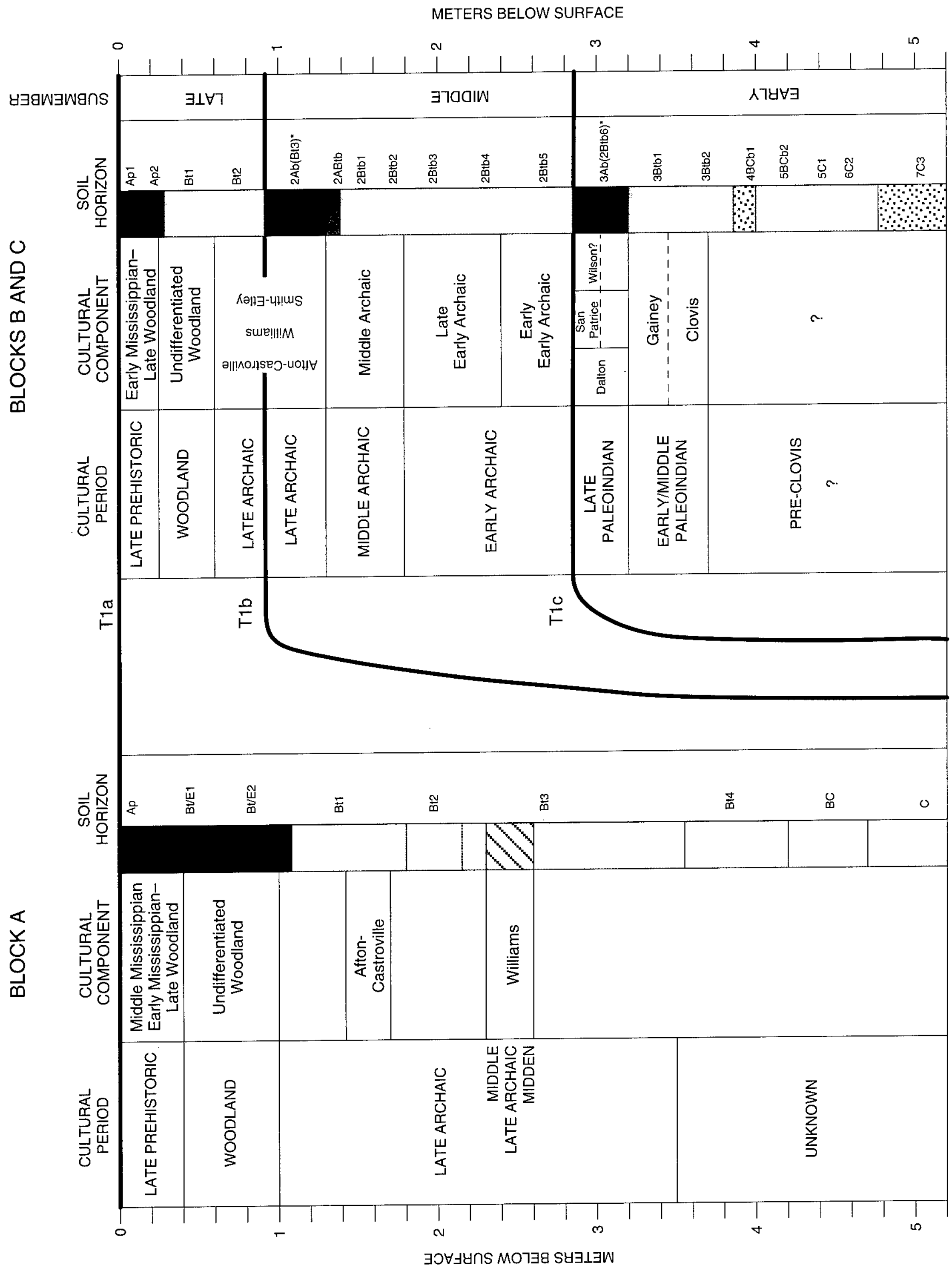
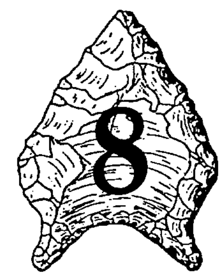


Figure 7.14. Schematic summary of the Rodger Shelter member geomorphic and cultural stratigraphy. The Block A stratigraphy depicts the late submember deposits on the west side of the block; however, the sloping T1b surface of the middle submember was present in the southeast corner of the block.

CULTURAL COMPONENTS



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A detailed discussion of the geomorphic structure of the site was presented in Chapter 7. Generalized profile columns of the site indicating soil horizons, stratigraphy, and inclusive cultural components are presented in Figure 7.14. In brief review, deep archaeological excavations were confined to two areas containing alluvial deposits that were chronostratigraphically distinct. In the area of Blocks B-D in the central part of the site, the entire Rodgers Shelter member is represented and is subdivided into early, middle, and late submembers. In this area, components dating from late-prehistoric through terminal Late Archaic times occur in a thin late Rodgers Shelter submember less than 1 m thick. This unit is underlain by a relatively thick middle Rodgers Shelter submember that contains early Late Archaic through early Early Archaic components. The lowest submember is late to terminal Pleistocene in age. It contains Late Paleoindian components confined to a 3Ab horizon, and Early/Middle Paleoindian and possibly earlier components in underlying 3Bt horizons.

In the west portion of the site, in the vicinity of Block A, a thick (5+ m) sequence of the late Rodgers Shelter submember is the only stratigraphic unit represented. Late-prehistoric through Woodland deposits occur in the upper deposits, whereas late Late Archaic and middle Late Archaic deposits are stratified in the middle part. The lowest portion of the thick late Rodgers Shelter submember was not investigated.

This chapter describes the prehistoric cultural components identified during the 1997 investigations at the Big Eddy site. The cultural components are discussed as they were encountered in the excavations from the top of the T1a terrace and late Rodgers Shelter submember (i.e., youngest cultural deposits) to the lower portion of the early Rodgers submember (i.e., oldest cultural deposits). Chipped-stone and other lithic assemblages are presented by cultural component in Table 8.1 and Table 8.2. Ground-stone tools are itemized by component in Table 8.3. Table 8.4 lists all cultural features found at the site. The lithic tables include only material from the 1997 investigations that could be reliably assigned to a component. Material from indeterminate contexts and artifacts found by collectors are not included, although some artifacts from those categories are presented in the following discussions. Complete lithic data are presented in Appendix 5.

Radiometric dates obtained from the Big Eddy site were presented earlier in Chapter 7 (Table 7.1). For simplicity and consistency, all references to radiometric ages in this chapter are presented in uncalibrated radiocarbon years before present (B.P.). Also note that whenever the terms early, middle, and late submember are used, they refer to the submembers of the Rodgers Shelter member.

LATE PREHISTORIC

Two late-prehistoric components have been identified at the Big Eddy site. One is clearly Middle/Late Mississippian in age, whereas the other appears to be slightly earlier and is generally associated with Late Woodland/Early Mississippian times. Most of the data pertaining to the late-prehistoric components were derived from the stripped surface after plow-zone removal. This resulted in the recovery of diagnostic lithic and ceramic artifacts, as well as the excavation of 13 prehistoric features. The plow-zone stripping was restricted entirely to the late submember; however, the west half

Table 8.1. Chipped-Stone Assemblage by Component.

	Woodland/ Mississippian		Woodland		Woodland/ Late Archaic		Late Late Archaic		Middle Late Archaic		Early Late Archaic		Middle Archaic	
Artifact Type	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Core Debitage														
Tested cobble					2	100.0			3	42.9	1	25.0		
Working core	2	100.0							3	42.9	3	75.0		
Exhausted core									1	14.3				
Total	2	100.0			2	100.0			7	100.0	4	100.0		
Flake Debitage														
Primary flake	8	9.0			2	1.6			28	4.7				
Secondary flake	14	15.7	1	12.5	18	14.1			107	17.9	2	5.7	2	22.2
Tertiary flake	12	13.5			13	10.2			40	6.7	2	5.7		
Biface flake	19	21.3	2	25.0	36	28.1			163	27.3	15	42.9	4	44.4
Flake fragment	36	40.4	5	62.5	59	46.1			260	43.5	16	45.7	3	33.3
Total	89	100.0	8	100.0	128	100.0			598	100.0	35	100.0	9	100.0
Informal Tools														
Utilized flake	1	100.0							3	100.0	2	66.7	2	100.0
Adze polished flake														
Other polished flake											1	33.3		
Total	1	100.0							3	100.0	3	100.0	2	100.0
Formal Tools														
Projectile point/knife	1	5.9	24	96.0			6	100.0	6	42.9	20	76.9		
Arrow point	16	94.1												
Adze											1	3.8		
Primary biface									1	7.1	1	3.8	1	50.0
Secondary biface									3	21.4	4	15.4	1	50.0
Tertiary biface			1	4.0					1	7.1				
Drill														
End scraper														
Graver														
Side scraper									2	14.3				
Unspecified scraper									1	7.1				
Total	17	100.0	25	100.0			6	100.0	14	100.0	26	100.0	2	100.0

Table 8.1. Chipped-Stone Assemblage by Component. (Continued).

	Late Early Archaic		Early Early Archaic		Late Paleoindian		Early/Middle Paleoindian		Pre-Clovis[a]		Total	
Artifact Type	N	%	N	%	N	%	N	%	N	%	N	%
Core Debitage												
Tested cobble					8	72.7	1	50.0			15	50.0
Working core			1	100.0	3	27.3	1	50.0			13	43.3
Exhausted core	1	100.0									2	6.7
Total	1	100.0	1	100.0	11	100.0	2	100.0			30	100.0
Flake Debitage												
Primary flake	4	17.4	13	3.7	276	2.8	14	2.7			345	2.9
Secondary flake	10	43.5	26	7.4	716	7.1	30	5.8			926	7.9
Tertiary flake			12	3.4	319	3.2	12	2.3			410	3.5
Biface flake	5	21.7	83	23.6	3,167	31.6	157	30.5	1	20.0	3,652	31.0
Flake fragment	4	17.4	217	61.8	5,538	55.3	301	58.6	4	80.0	6,443	54.7
Total	23	100.0	351	100.0	10,016	100.0	514	100.0	5	100.0	11,776	100.0
Informal Tools												
Utilized flake			1	100.0	30	73.2	6	85.7			45	77.6
Adze polished flake					5	12.2					5	8.6
Other polished flake					6	14.6	1	14.3			8	13.8
Total			1	100.0	41	100.0	7	100.0			58	100.0
Formal Tools												
Projectile point/knife	5	62.5	3	33.3	7	5.5	2	33.3			74	30.8
Arrow point											16	6.7
Adze					1	0.8					2	0.8
Primary biface	1	12.5	2	22.2	31	24.4					37	15.4
Secondary biface	1	12.5	3	33.3	60	47.2	2	33.3			74	30.8
Tertiary biface			1	11.1	6	4.7					9	3.8
Drill	1	12.5			1	0.8					2	0.8
End scraper					11	8.7	1	16.7			12	5.0
Graver					2	1.6	1	16.7			3	1.3
Side scraper					5	3.9					7	2.9
Unspecified scraper					3	2.4					4	1.7
Total	8	100.0	9	100.0	127	100.0	6	100.0			240	100.0

[a]One biface flake and two flake fragments were recovered from a probable rodent burrow, making their assignment to this component tentative.

Table 8.2. Other Lithics by Component.

	Ground-Stone Tools		Pigment		Fire-Cracked Rock		Shatter		Unmodified		Total	
Component	N	%	N	%	N	%	N	%	N	%	N	%
Woodland/Mississippian							5	41.7	7	58.3	12	100.0
Woodland					4	100.0					4	100.0
Woodland/Late Archaic					4	13.3	26	86.7			30	100.0
Middle Late Archaic	1	1.0	18	18.8	30	31.3	37	38.5	10	10.4	96	100.0
Early Late Archaic					13	40.6	4	12.5	15	46.9	32	100.0
Middle Archaic	3	42.9					3	42.9	1	14.3	7	100.0
Late Early Archaic	1	50.0			1	50.0					2	100.0
Early Early Archaic	2	8.3			5	20.8	17	70.8			24	100.0
Late Paleoindian	10	3.2	10	3.2	136	43.7	145	46.6	10	3.2	311	100.0
Early/Middle Paleoindian			3	5.1	15	25.4	34	57.6	7	11.9	59	100.0
Pre-Clovis							1	100.0			1	100.0
Indeterminate	4	5.0	3	3.8	39	48.8	32	40.0	2	2.5	80	100.0
Total	21	3.2	34	5.2	247	37.5	304	46.2	52	7.9	658	100.0

Table 8.3. Ground-Stone Tools and Pigments by Component.

Type	Raw Material	N	Description
Middle Late Archaic			
Multipurpose	Jefferson City sandstone	1	Nutting stone/anvil/hammerstone/ochre
Pigment	Limonite	2	Unmodified
Pigment	Limonite	1	1 scratched surface
Pigment	Hematite	1	3 faceted surfaces
Pigment	Limonite	1	Unmodified
Pigment	Hematite	6	5 exhibit 1 faceted surface each
Pigment	Hematite	1	1 scratched surface
Pigment	Hematite	1	1 fluted surface
Pigment	Hematite	1	1 facet
Pigment	Hematite	4	1 faceted (2 sides)
Middle Archaic			
Grooved abrader	Warner sandstone	1	1 face grooved; coated with hematite
Faceted abrader	Warner sandstone	2	Both coated with hematite
Late Early Archaic			
Metate	Warner sandstone	1	1 faceted surface
Early Early Archaic			
Faceted abrader	Warner sandstone	1	1 facet
Faceted abrader	Jefferson City sandstone	1	1 facet
Late Paleoindian			
Battered pebble	Burlington chert	1	
Faceted abrader	Jefferson City sandstone	1	4 faceted faces
Faceted abrader	Warner sandstone	1	1 faceted face
Faceted abrader	Warner sandstone	1	1 faceted face
Grooved abrader	Warner sandstone	1	Shallow and deep grooves on 2 faces and 2 sides
Grooved abrader	Warner sandstone	1	1 grooved face
Grooved abrader	Warner sandstone	1	Shallow groove on 1 face
Grooved abrader	Northview siltstone	1	1 face with multiple striations
Hammerstone	Burlington chert	1	Light-duty battering
Mano	Jefferson City sandstone	1	Lightly ground on 1 face
Pigment	Hematite	1	Scratched/cut on 2 faces
Pigment	Hematite	3	Unmodified
Pigment	Hematite	1	Unmodified
Pigment	Limonite	1	Unmodified
Pigment	Hematite	1	Unmodified
Pigment	Hematite	1	Unmodified
Pigment	Hematite	1	Unmodified
Pigment	Hematite	1	Unmodified
Early/Middle Paleoindian			
Pigment	Hematite	1	Unmodified
Pigment	Hematite	2	Unmodified
Indeterminate			
Grooved abrader	Warner sandstone	1	Shallow groove on 1 face
Pigment	Hematite	1	Unmodified
Pigment	Hematite	1	Unmodified
Pigment	Hematite	1	Unmodified
Pitted stone	Warner sandstone	1	3 pits
Pitted stone	Warner sandstone	1	3 pits

Table 8.4. Defined Features at the Big Eddy Site.

Feature	Feature Type	Location	Component	Rodgers Shelter Submember
1	Pit	Stripped surface	Woodland/Mississippian	Late
2	House?	Stripped surface	Middle Mississippian[a]	Late
3	Pit	Stripped surface	Woodland/Mississippian	Late
4	Root mold	Stripped surface	Woodland/Mississippian	Late
5	Root mold	Stripped surface	Woodland/Mississippian	Late
6	Post	Stripped surface	Woodland/Mississippian	Late
7	Pit	Stripped surface	Woodland/Mississippian	Late
8	Pit	Stripped surface	Woodland/Mississippian	Late
9	Post	Stripped surface	Woodland/Mississippian	Late
10	Pit?	Stripped surface	Woodland/Mississippian	Late
11	Pit	Stripped surface	Woodland/Mississippian	Late
12	Pit	Stripped surface	Woodland/Mississippian	Late
13	Post	Stripped surface	Woodland/Mississippian	Late
14	Root mold	Stripped surface	Woodland/Mississippian	Late
15	Smudge pit	Stripped surface	Woodland/Mississippian	Late
16	Post	Stripped surface	Woodland/Mississippian	Late
17	Tree burn	Block A, Stripped surface	Early Late Archaic	Late
18	Refuse dump	Trench 1	Middle Late Archaic	Late
19	Tree burn	Block A, Stripped surface	Early Late Archaic	Late
20	Refuse dump	Block A, TU 5	Middle Late Archaic	Late
21	Ochre deposit	Block B, Stripped surface	Middle Archaic	Middle
22	Refuse dump	Block A, TU 9	Middle Late Archaic	Late
23	Knapping pile	Block B, TU 8	Late Paleoindian	Early
24	Knapping pile	Block B, TU 12	Late Paleoindian	Early
25	Gravel pile	Block B, TU 16/17	Late Paleoindian	Early
26	Knapping pile	Block B, TU 13	Late Paleoindian	Early
27	Knapping pile	Block B, TU 15	Late Paleoindian	Early
28	Knapping pile	Block B, TU 4/21/22	Late Paleoindian[a]	Early
29	Knapping pile	Block B, TU 21/22/25/26	Late Paleoindian[a]	Early
30	Refuse dump	Block A, Stripped surface	Middle Late Archaic[a]	Late
31	Refuse dump	Block A, Stripped surface	Middle Late Archaic	Late
32	Knapping pile	Block B/C, TU 12/26	Late Paleoindian	Early
33	Knapping pile	Block C, TU 26	Late Paleoindian	Early
34	Tree burn	Block C, TU 25	Late Paleoindian	Early
35	Tree burn	Block C, TU 24/25	Late Paleoindian	Early
36	Knapping pile	Block C, TU 32	Late Paleoindian	Early
37	Gravel pile	Block C, TU 27/32	Late Paleoindian	Early
38	Knapping pile	Block C, TU 25/26	Late Paleoindian	Early
39	Tree burn	Cutbank	Late Paleoindian/Early Archaic[a]	Early/Middle
40	Knapping pile	Block C, TU 23	Late Paleoindian	Early
41	Knapping pile	Block D, TU 33	Late Paleoindian	Early
42	Knapping pile	Block D, TU 30	Late Paleoindian[a]	Early
43	Knapping pile	Block B, TU 8	Late Paleoindian	Early
44	Knapping pile	Block C, TU 27	Late Paleoindian	Early
45	Knapping pile	Cutbank	Late Paleoindian	Early
46	Tree burn	Cutbank	n/a[a]	Middle

[a]Feature has associated radiocarbon date.

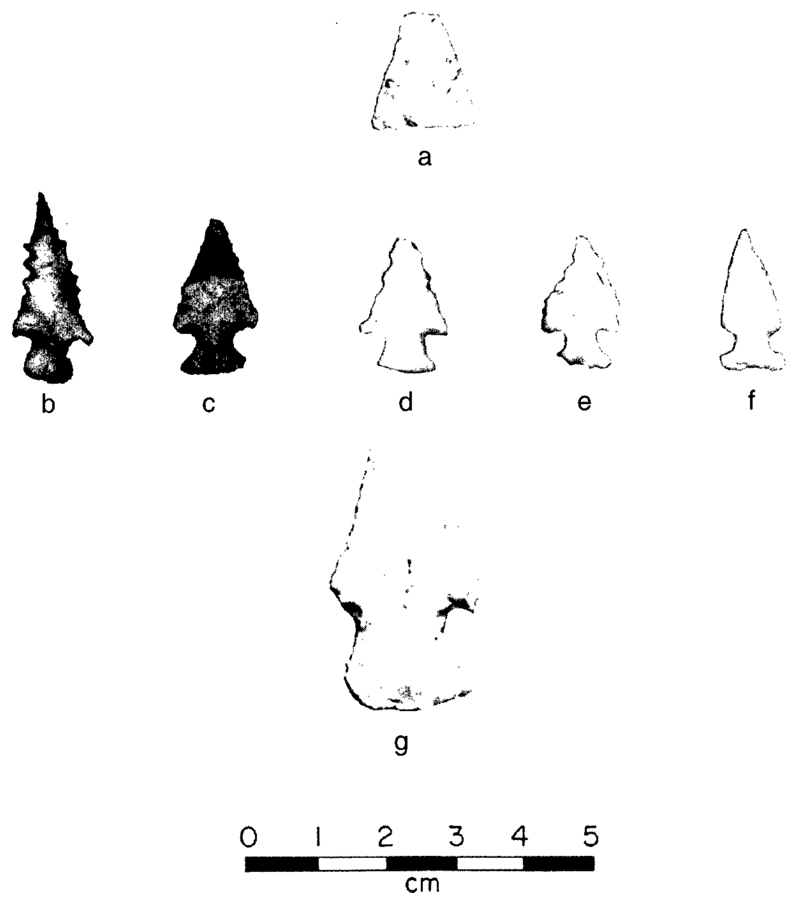


Figure 8.1. Late prehistoric projectile points: (a) Madison Triangle arrowpoint; (b-e) Scallorn Corner Notched arrowpoints; (f) Reed Side Notched arrowpoint; (g) Cupp Corner Notched dart point/knife.

of the stripped surface was situated on a thick deposit of the late submember (hereafter referred to as the thick late submember), whereas the eastern half was situated on thin late submember deposits (hereafter referred to as the thin late submember, see Chapter 7).

Middle/Late Mississippian Component

The Middle/Late Mississippian component is poorly represented at the site. In fact, only one diagnostic artifact, a Madison Triangular arrowpoint (Figure 8.1a), and one feature radiocarbon dated to 760 ± 70 B.P. (Beta-117783) (see Feature 2 discussion below) appear to be related to this component. Both were discovered at the west end of the site (late submember) during plow-zone stripping. In southwest Missouri, Madison (also known as Fresno and Mississippi Triangular) points are generally restricted to the Middle and Late Mississippian periods; however, they are affiliated with several different phases. Madison points have been firmly associated with a Neosho phase site in the Spring River valley in Lawrence County that dated to the middle fifteenth century (Conner 1996). They are also associated with Oneota in northern Missouri and with various Early to Late Mississippian phases in the Mississippi River valley to the east. Middle/Late Mississippian utilization in the Sac River valley apparently was limited (Chapman 1980:228–229);

however, one site (23CE433) located upstream of Big Eddy appears to have been utilized more intensively. Monitoring of the cutbank at this location by A. Clark Montgomery for over 10 years has yielded several Middle/Late Mississippian artifacts including Huffaker, Cahokia, Madison, and Scallorn arrowpoints, Table Rock Pointed Stem and Cupp Corner Notched knives, and a very unusual female effigy pipe.

Late Woodland/Early Mississippian Component

A more sustained Late Woodland/Early Mississippian occupation is indicated at the Big Eddy site by the recovery of several Scallorn Corner Notched arrowpoints (Figure 8.1b-e). In southwest Missouri, Scallorn points have a relatively long temporal span, appearing sometime in the late Middle Woodland or early Late Woodland period and extending into the Early and Middle Mississippian periods (Chapman 1980:312; O'Brien and Wood 1998:235–236). Most radiocarbon dates associated with Scallorn points from the southwestern Ozarks, however, tend to place them in the Late Woodland period (Benn and Ray 1996; Chapman 1980; Dickson 1991; Guendling 1992; Ray 1988, 1995a, 1995b; Ray and Benn 1992). In addition, although Scallorn-style arrowpoints appear to have continued into the Early and Middle Mississippian periods, the cultural tradition associated with Scallorn points in the southwestern Ozarks follows a Late Woodland cultural pattern (Benn and Ray 1996).

Twelve Scallorn arrowpoints were found during the project: two during plow-zone stripping, six from plow-zone backdirt piles, three on cutbank slump deposits from the late submember, and one from general cutbank deposits. Other Late Woodland/Early Mississippian points recovered from the plow zone and the late submember are one Reeds Side Notched arrowpoint (Figure 8.1f), one Cupp Corner Notched dart point/knife (Figure 8.1g), and two unidentifiable arrowpoint fragments.

Relatively few ceramic artifacts were recovered from the Big Eddy site. Eleven plain, sand-and-grit-tempered sherds were found just below the plow zone (25–29 cm) in a restricted location in the northwest corner of the stripped area. All 11 sherds belong to a single broken pottery vessel; 10 of the 11 sherds were found within an area of approximately 12 x 12 m (Figure 8.2). All of the sherds exhibit the same oxidized exterior (10R 4/6) and reduced interior (10YR 3/2). Sand is the dominant tempering agent, but grit (hematite, chert, and calcite) particles are also common along with smaller amounts of limestone and siltstone particles. Nine are body sherds and two are rim sherds. Both rim sherds exhibit a vertical to slightly recurved profile with smooth, rounded, or slightly flattened lips. Although there is no known pottery type directly applicable to the ware recovered from the Big Eddy site, similar limestone-and-grit-tempered pottery associated with occasional shell-tempered sherds has been found at several mound, sheltered, and open-air sites in the Sac River basin (Benn and Ray 1996:58–62; Chapman 1980:80–86; Wood and Brock 1984:116).

Most of the evidence points to a Late Woodland/Early Mississippian affiliation, although there are some indications that the pottery is affiliated with the Middle Mississippian component. The Madison point was found near the middle of the ceramic scatter, and the pot sherds were found at approximately the same elevation as Feature 2, which was dated to the Middle Mississippian period. Middle Mississippian pottery, however, is almost always shell tempered, whereas Late Woodland/Early Mississippian pottery in southern Missouri is highly variable in tempering, often exhibiting a combination of two or more types (Benn and Ray 1996:58–62; Chapman 1980:80–86; Ray 1988:5, 1995b:46–47; Wood and Brock 1984:116). Based on rim form, surface finish, and variable temper, the pottery appears to be most closely related to the early Woodward ceramic series of Caddoan cultures (Chapman 1980; House 1978; Perttula 1989), which indicates that it is probably affiliated with the Late Woodland/Early Mississippian tradition.

Based on the relatively large sample of Scallorn arrowpoints recovered from the site, it would also appear that the Late Woodland/Early Mississippian component represents a more intensive or longer-term occupation than the Middle/Late Mississippian component. Pottery is generally associated with sedentary or semi-sedentary habitation as opposed to ephemeral occupation. Finally, it is possible that the pottery and Scallorn arrowpoints date to the Middle Mississippian period, since, as noted above, Scallorn arrowpoints continued to be made well into the Middle Mississippian period in the western Ozarks.

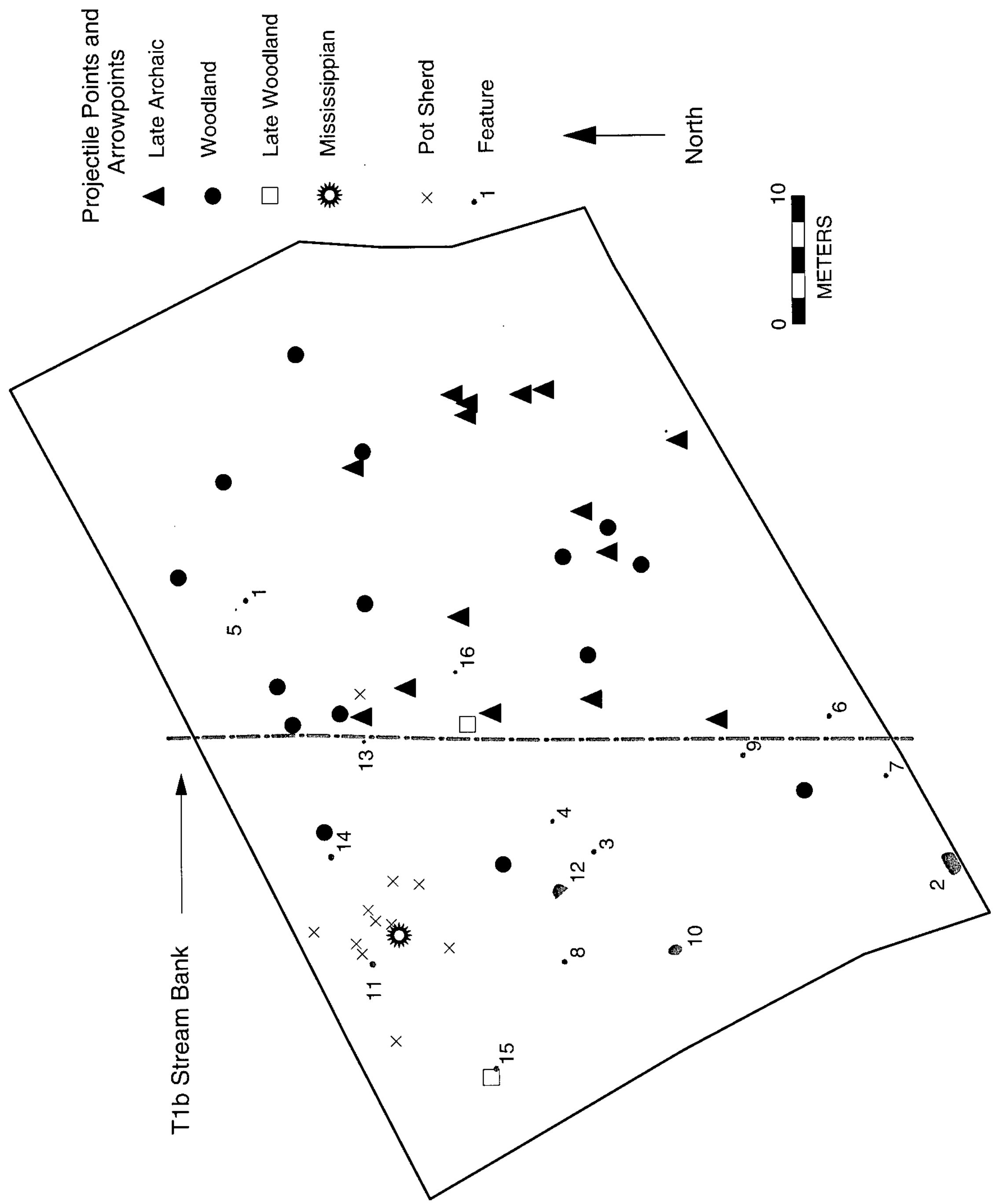


Figure 8.2. Diagnostic artifacts and cultural features on the stripped surface.

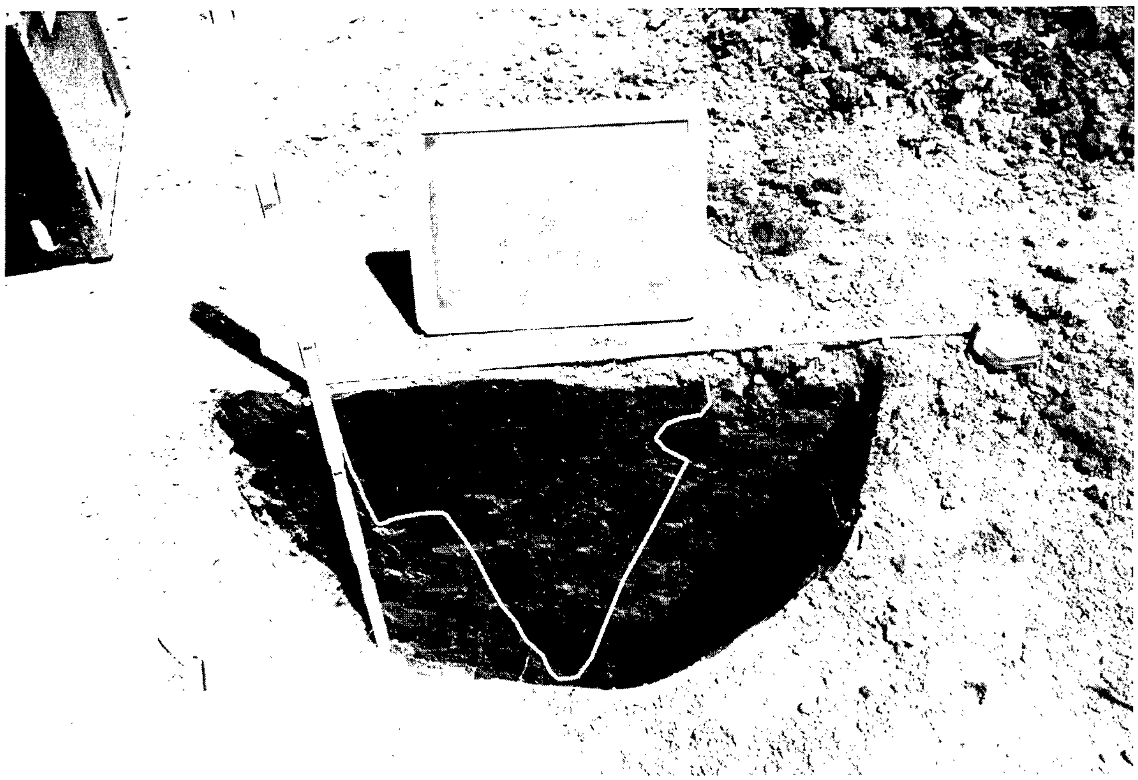


Figure 8.3. Profile of Feature 4, a burned root feature with a deep V-shaped structure.

Features

Schmits (1988:114) reported finding only one cultural feature during his test excavations at Big Eddy. It was located in the southwest part of the site just below the plow zone. It consisted of a sparse concentration of charcoal, burned soil, debitage, and apparently fire-cracked rock. Numerous similar features were encountered during the 1997 excavations. Plow-zone stripping revealed a minimum of 38 feature-like stains, most of which were clustered in the western portion of the site where the thick late submember occurs. In plan view, these stains generally exhibited a round or oval shape with variable amounts of charcoal, ash, and burned soil (i.e., sparsely scattered or in concentrated pockets). Subsequent profiling and excavation revealed that the majority of the stains represented natural redoximorphic features (Vepraskas 1992). Specifically, these redoximorphic features represent tree root molds with deep V-shaped structures and occasional lateral branches (Figure 8.3). The V-shaped, very dark grayish brown (10YR 3/2) structures in the center of the stains were often bordered by grayish brown (10YR 5/2) reduced (Fe_2O_2-iron depleted) zones, which in turn were bordered by a reddish brown (5YR 4/4) to yellowish red (5YR 5/6) highly oxidized (Fe_2O_3-iron enriched) zone. Such attributes are characteristic of redoximorphic features (Vepraskas 1992:6–10). The fill of these stains contained few if any prehistoric artifacts. Of the 38 stains identified on the stripped surface, 22 were determined in the field to be noncultural features after cross-sectioning.

Each of the remaining 16 stains was assigned a feature number, and flotation samples were collected for laboratory analysis. The results of this analysis, considered in conjunction with feature morphology and presence/absence of artifacts, were used to determine whether the remaining 16 features were natural or cultural. With a few exceptions, flotation samples extracted from the features

were generally 9 liters or more in volume. The results of the botanical analyses are detailed in Chapter 10.

Based on all of the available data, 13 of the 16 designated features appear to be cultural in origin, and three (Features 4, 5, and 14) are assessed as burned roots, possibly associated with early historic field clearing (Table 8.4). The cultural features consist of eight pit features, four post features, and one possible structural (house) feature. Figure 8.2 shows the distribution of the 16 designated features across the stripped surface. All but four of these features were associated with the thick late submember located on the west half of the stripped surface. All of the features were assigned to late-prehistoric components except two that were assigned to the Woodland component.

Feature 2

This feature was discovered on the west side of the site in the southwest corner of the stripped surface at a depth of 26–28 cm below surface (bs) during plow-zone removal (Figure 8.2). Stratigraphically, the feature was situated at the top of the thick late submember. It consisted of a dispersed scatter of large chunks (up to 5 x 15 cm) of wood charcoal that exhibited no definitive pattern or clear boundary. The charcoal scatter was mapped (Figure 8.4a), and a sample of charcoal was recovered. The feature was later re-examined and remapped after an additional 5–10 cm of soil was stripped from the area. Although the distribution of the charcoal changed (Figure 8.4b), it still exhibited a dispersed pattern covering an area of approximately 1.2 m northeast to southwest x 2.6 m northwest to southeast. Two additional charcoal samples were collected from the feature at a depth of 38 cm bs. Sample 1 was submitted for radiocarbon analysis; it yielded an age of 760 ± 70 B.P. (cal A.D. 1280) (Beta-117783). Approximately 3 liters of soil also were collected from Feature 2 and processed via flotation. Forty pieces of wood charcoal (20 from each flotation sample) were selected for taxonomic identification. All consist of maple wood.

The current evidence is inconclusive regarding the origin (natural vs. cultural) of this prehistoric feature. It could simply represent naturally dispersed elements of a burned maple tree. On the other hand, it could represent wood that was burned in relation to an indeterminate cultural activity. It is also possible that this feature may represent the dispersed elements of a burned prehistoric structure. There were, however, no discernible post molds associated with the charcoal remains; nor were there any refuse pits, hearths, or prehistoric tools directly associated with the feature. The dimensions of Feature 2 are also small for house structures that have been identified previously in the Sac River valley (Calabrese et al. 1969; Chapman 1980). At the Dryocopus, Flycatcher, and Shady Grove sites, purported Late Woodland/Mississippian houses varied in size from approximately 3.7 m to 5.5 m in diameter (Chapman 1980:83–86). It must be pointed out, however, that Feature 2 was situated on the south edge of the stripped surface (Figures 8.2 and 8.4), and thus, it may not have been fully exposed by the plow-zone stripping. Future work at the Big Eddy site should investigate this unexcavated area to help determine the origin and nature of this feature.

Feature 3

Feature 3 consisted of a circular stain with a bowl-shaped profile (Figure 8.5). The fill contained charcoal, burned soil, and pebbles. No artifacts were recovered from the feature; however, botanical remains were common and quite diverse. Identified wood taxa include red oak, indeterminate oak, walnut, and cottonwood/willow, and identified seed taxa consist of ragweed, cherry, dock, and wild grape. The feature appears to represent a storage/refuse pit.

Feature 4

This feature was identified on the stripped surface as a potential posthole containing dark brown (10YR 3/2) soil and dispersed charcoal. It exhibited a V-shaped profile (Figures 8.3 and 8.5). No artifacts were recovered. Flotation analyses revealed that botanical remains consisted mostly of fungal material (n=1,634) and a few fragments of wood charcoal. This feature appears to be noncultural in origin, probably representing a burned and/or decomposed tree root system.

Feature 6

This feature was mapped as occurring in the thin late submember just east of the T1b stream bank (Figure 8.2), but it may actually be associated with the thick late submember. The feature con-

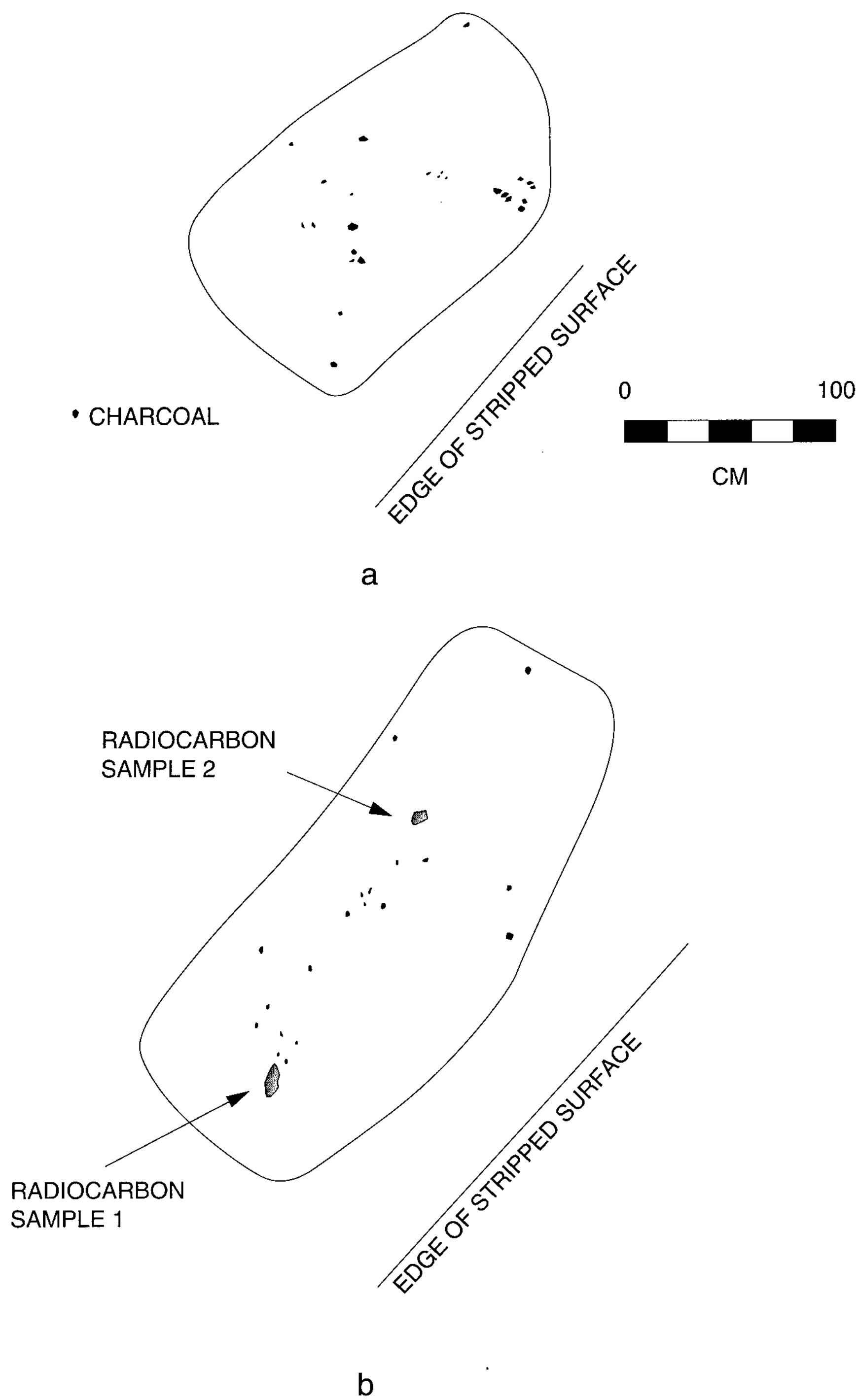


Figure 8.4. Two plan views of Feature 2 at approximately 27 cm bs (a) and 35 cm bs (b).

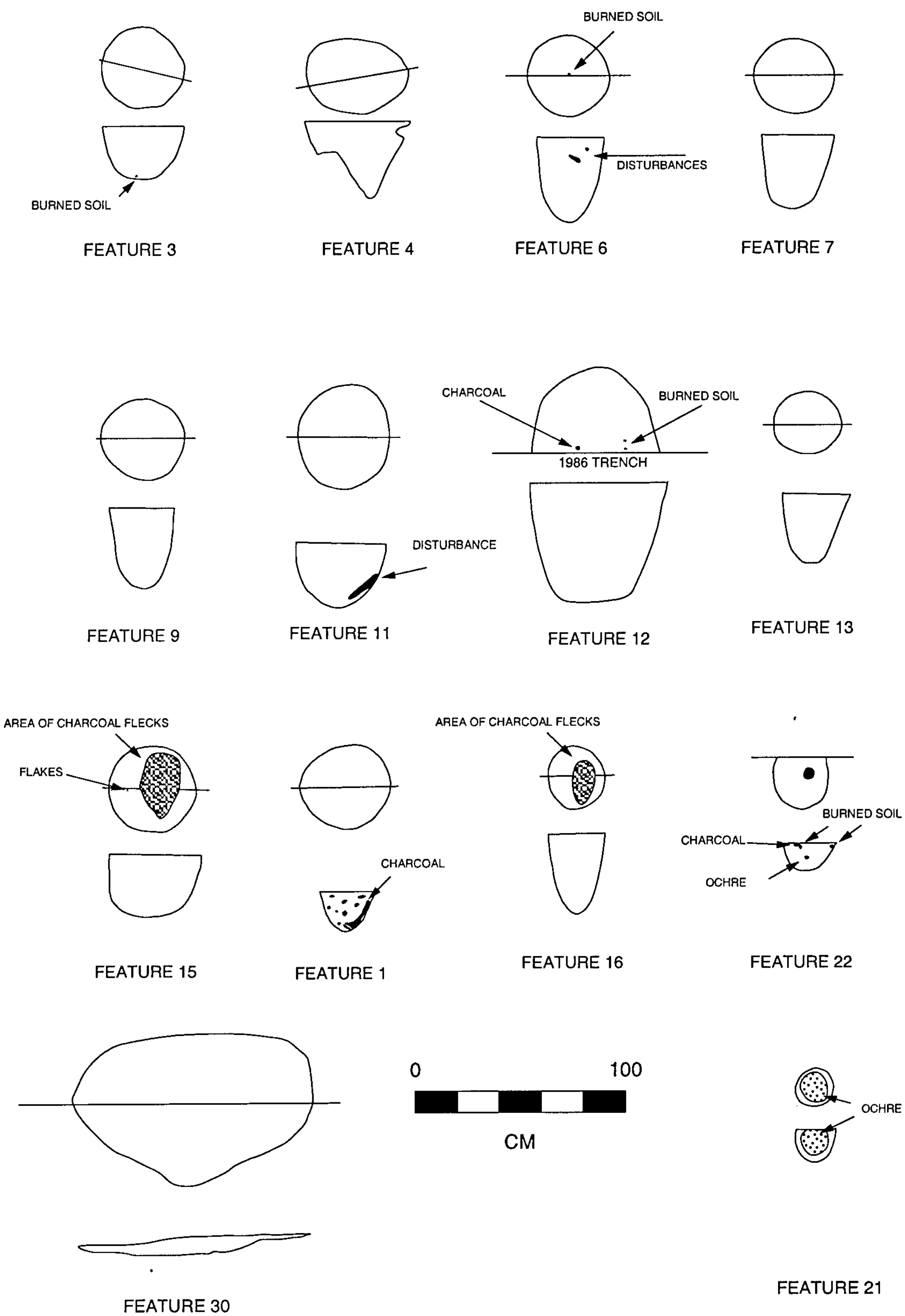


Figure 8.5. Plan views and profiles of features.

sisted of a relatively diffuse stain with charcoal, oxidized soil, and a light scatter of artifacts. It measured approximately 32 cm in diameter and extended about 40 cm below the stripped surface (Figure 8.5). Small areas of bioturbation were evident in the upper portion of the feature. Lithic artifacts include two tertiary flakes, two flake fragments, and one piece of chert shatter. Eleven microflakes were recovered from the flotation sample. The flotation sample also yielded a variety of botanical remains including charred hickory, ash, and locust/coffeetree wood, one indeterminate carbonized seed, hickory nut shell, and walnut shell. Feature 6 appears to represent a large, deep posthole.

Feature 7

This pit feature was located on the south edge of the stripped surface approximately 40 m northeast of Feature 2. It consisted of a dark (10YR 4/3) circular stain with a few charcoal inclusions. In profile the feature extended approximately 35 cm below the stripped surface and exhibited a rounded, pit-like base (Figure 8.5). Artifacts found in the feature fill include one biface flake, three flake fragments, and two pieces of chert shatter. A flotation sample yielded nearly 350 pieces of wood charcoal (20 of which were identified as walnut), one knotweed seed, one indeterminate charred seed, four pieces of walnut shell, two fragments of Juglandaceae nut shell, and one microflake.

Feature 8

Feature 8 was identified as a dark circular stain containing scattered chunks of charcoal. The feature measured approximately 36 cm in diameter at the stripped surface; however, the base of the feature was very faint. No artifacts were recovered from the excavated portion. The flotation sample, however, yielded 161 pieces of wood charcoal of which 20 were identified as walnut, one cherry seed, two hickory nut shell fragments, one walnut shell fragment, and one microflake. Feature 8 appears to represent a small pit.

Feature 9

This feature was described as a diffuse stain with scattered charcoal flecks. It measured about 31 cm in diameter and extended approximately 37 cm below the stripped surface (Figure 8.5). The flotation sample yielded several pieces of wood charcoal, including at least two fragments of white oak, one piece of indeterminate oak, and 17 fragments of hickory; one wild grape seed; five fragments of Juglandaceae nut shell; one indeterminate fragment; and three microflakes. Feature 9 appears to represent a large posthole.

Feature 10

When first identified on the stripped surface, Feature 10 appeared as a large stain (10YR 4/3) approximately 110 cm in diameter; it contained large chunks of charcoal and small pieces of burned soil. However, when cross-sectioned the feature fill was very diffuse and appeared to have been disturbed extensively by bioturbation. The flotation sample contained abundant wood charcoal, 20 fragments of which were identified as cherry wood. Other items were five carbonized bedstraw seeds, one indeterminate seed, one walnut shell fragment, and one microflake. The extensive disturbances preclude a positive identification; however, this feature appears to represent a possible pit.

Feature 11

This pit feature consisted of a brown (10YR 4/3) circular stain containing a light scatter of charcoal and burned soil. It was approximately 43 cm in diameter at the stripped surface, extended to a depth of about 30 cm, and had a rounded base (Figure 8.5). Three artifacts recovered from the excavated and screened portion of the feature are one piece of chert shatter, one piece of fire-cracked siltstone, and one large unmodified Burlington chert cobble. Flotation materials consisted of three wood charcoal fragments, one indeterminate seed, one hazelnut shell fragment, a trace of acorn shell, and four microflakes.

Feature 12

Feature 12 was identified on the stripped surface as a semi-circular stain exhibiting charcoal chunks and burned soil. Closer inspection revealed that the feature was bisected by a 1986 test trench (Schmits 1988), obliterating the western half. This feature was approximately 60 cm in diameter and extended to a depth of at least 56 cm below the stripped surface (Figure 8.5). The feature yielded

one flake fragment, two pieces of fired clay, and an assortment of botanical materials: 14 fragments of walnut wood, two fragments of hackberry/elm wood, one fragment of sassafras wood, two bedstraw seeds, one white avens seed, two wild grape seeds, one indeterminate seed, four pieces of walnut shell, and six pieces of Juglandaceae nut shell. The shape and contents of Feature 12 indicate that it probably represents a storage/refuse pit.

Feature 13

This feature consisted of a brown (10YR 4/3) circular stain with scattered charcoal and burned soil. It measured approximately 33 cm in diameter at the stripped surface and extended to a depth of about 32 cm (Figure 8.5). Two flotation samples were removed from Feature 13; they yielded a variety of botanical material. Identified specimens of wood consisted of two white oak, 13 red oak, one indeterminate oak, two ash, two locust/coffeetree, and 20 walnut fragments. One acorn shell, one white avens seed, one stargrass seed, one purslane seed, two grass family seeds, one indeterminate seed, and three microflakes were also recovered. This feature has been identified as a possible post.

Feature 14

This feature was identified as a very diffuse round stain containing scattered charcoal and burned soil. It contained no artifacts. The flotation sample yielded 117 pieces of wood charcoal and one chenopod seed. A subsample of the wood charcoal indicates the presence of a single species (maple). The limited data imply that this feature probably represents the remains of a burned tree root system.

Feature 15

Feature 15 was identified as a circular brown (10YR 4/3) stain with large chunks of charcoal. It measured approximately 44 cm in diameter and extended to a depth of about 29 cm below the stripped surface (Figure 8.5). The bottom portion of the feature appeared to have been bioturbated. Six lithic artifacts were recovered from the screened portion of the feature: one piece of unmodified siltstone, one utilized flake, one tertiary flake, two biface flakes, and one flake fragment. At least three of the flakes were knapped from a common cobble of Ellipsoidal Jefferson City chert (see Chapter 9). The flotation sample from Feature 15 yielded 18 microflakes, 52 fragments of wood charcoal, 1,072 pieces of bark, and one twig fragment. The small sample of wood revealed the presence of red oak, indeterminate oak, hickory, and locust/coffeetree. The size, shape, and botanical remains suggest that this feature represents a small smudge pit (see Chapter 10).

Summary and Conclusion

The late-prehistoric deposits at the Big Eddy site have been largely disturbed by plow agriculture. This is especially true of late-prehistoric deposits located on the thin portion of the late submember (i.e., east half of the stripped surface). In fact, only three prehistoric features were discovered on the thin late submember, and only one of these (Feature 6) appears to date to late-prehistoric times. Very little sedimentation occurred on this stable portion of the terrace during the last 1,000–1,500 years. Indeed, it is probable that practically all evidence of late-prehistoric activities on the thin late submember have been consumed by the 27-cm-thick plow zone. As a result, late-prehistoric features are concentrated on the west half of the stripped surface where the late submember is thick. There is no discernible patterning to the features in this area. Most are pit features that appear to be randomly distributed, and there are too few posts to discern any coherent structural patterns. Feature 2 may represent a burned residential structure, although more work needs to be conducted on the south side of this feature to confirm or negate this possibility. Additional late-prehistoric (especially Late Woodland) features may be located below the stripped surface in the upper portion of the thick late submember.

At least two late-prehistoric components are represented at the Big Eddy site. The most intensive occupation appears to have occurred during the Late Woodland/Early Mississippian period and is associated with the small corner-notched (Scallorn) arrowpoints and probably the plain sand-and-grit-tempered pot sherds. Based on the relative lack of pottery (one vessel), cultural features (especially hearths), and cultivated food stuffs, however, this component does not appear to represent a permanent settlement. Instead, it probably was a hunting and gathering field camp seasonally reoccupied during Late Woodland/Early Mississippian times.

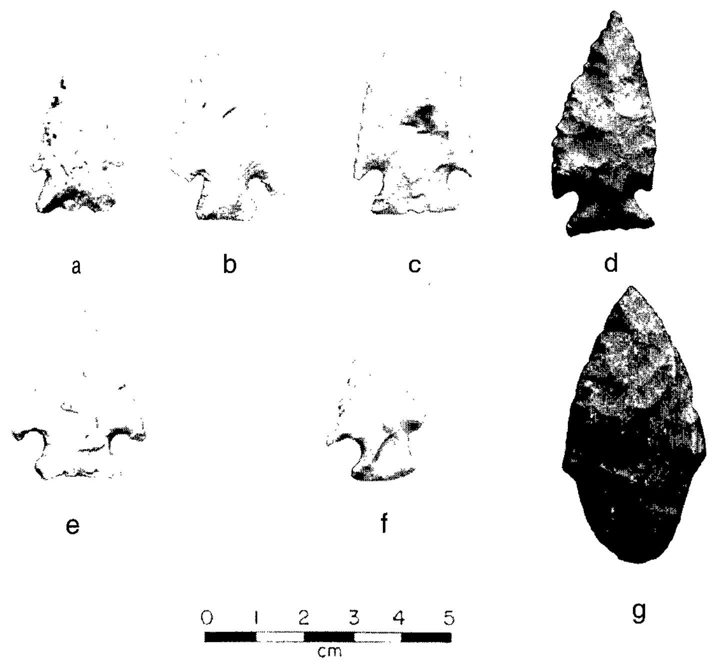


Figure 8.6. Woodland dart points: (a-f) Kings Corner Notched; (g) Waubesa Contracting Stem.

A separate Middle/Late Mississippian occupation is represented by one triangular arrowpoint. Although it yielded a Middle Mississippian date, it is unclear if the possible house structure (Feature 2) is associated with the corner-notched arrowpoints (Scallorn component) or the triangular arrowpoint (Madison component). In either case, it is probable that Middle/Late Mississippian use of Big Eddy was ephemeral or short term.

WOODLAND

An undifferentiated Woodland component at the Big Eddy site is represented by a small amount of debitage collected from Test Unit 1, several diagnostic projectile points/knives, and two cultural features. Artifacts in TU 1 (25–125 cm bs) were sparse with each level yielding three or fewer lithic items. Most of the Woodland artifacts were recovered from disturbed contexts, including a total of 24 projectile points/knives. Most of these points were discovered during plow-zone stripping and others were found out of context on backdirt piles, cutbank slumpage, or gravel bars adjacent to the site. The most common Woodland point type is Kings Corner Notched (Figure 8.6a-f) with 15 specimens. Kings Corner Notched is a relatively poorly defined type that includes most medium-sized dart points with deep corner notches and straight to slightly concave bases. They may have a relatively long temporal span from Late Archaic to Late Woodland times; however, most seem to date to the Middle Woodland and/or Late Woodland period (Chapman 1980:309; O'Brien and Wood 1998:234). More extensive work needs to be conducted in the Ozarks, however, to refine the typological attributes and temporal range of this common point type.

Eleven of the 15 Kings Corner Notched points were found in semi-disturbed contexts during plow-zone stripping, either within or at the base of the plow zone. All but two were found on the east half of the stripped surface where the late submember is thin (Figure 8.2). One Kings Corner Notched point found at a depth of 35 cm in the thin late submember may have been in situ. Five Kings Corner Notched points were also found at the Big Eddy site during previous investigations (Schmits 1988:Figure 24). Although none were recovered in situ, Schmits (1988:117) associated Kings Corner Notched points with an "upper component" at 30–60 cm bs. Based on available data and stratigraphic

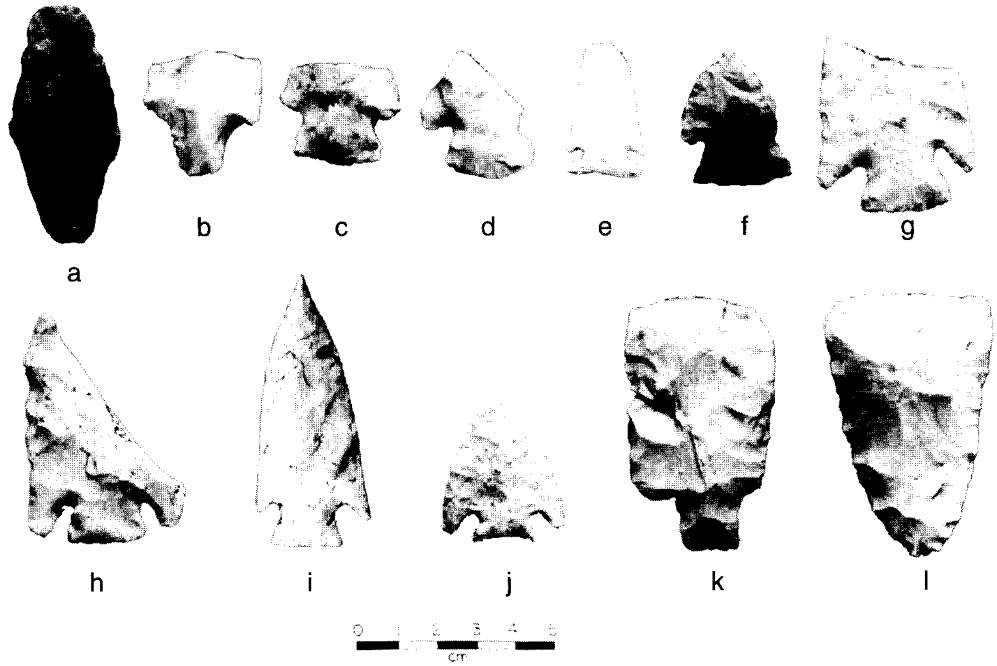


Figure 8.7. Woodland and Archaic artifacts: (a) Standlee Contracting Stem; (b) Gary Contracting Stem; (c-d) Lander Corner Notched; (e) Little Sac Corner Notched; (f) Marcos Corner Notched; (g-h) Castroville Corner Notched; (i-j) Afton Corner Notched; (k) Table Rock Stemmed; (l) Clear Fork biface.

relationships to earlier and later artifacts, it appears that Kings Corner Notched points probably occur at a depth of approximately 40–100 cm in the thick late submember and only 25–60 cm in the thin late submember.

Other Woodland point types recovered during the 1997 investigations are represented by only one or two specimens each: one Standlee (Langtry) Contracting Stemmed (Figure 8.7a), one Gary Contracting Stemmed (Figure 8.7b), two Lander Corner Notched (Figure 8.7c-d), two Little Sac Corner Notched (Figure 8.7e), one Marcos Corner Notched (Figure 8.7f), one Waubesa Contracting Stemmed (Figure 8.6g), and one unidentifiable (extensively resharpened) Woodland point. Of these Woodland points, Standlee Contracting Stemmed, Gary Contracting Stemmed, and Lander Corner Notched probably date to Middle Woodland times, whereas the Waubesa (Adena-like) and Marcos points are probably Early Woodland. The Waubesa point is the only Woodland artifact that was manufactured from an exotic raw material. It was made from a gray fossiliferous Pennsylvanian chert that appears to be Florence B chert from east-central Kansas.

Features

Three features are interpreted as Woodland in age due to their location on the east half of the stripped surface in the thin late submember. As noted above, it is probable that plow-zone mixing destroyed practically all late-prehistoric activity on the thin late submember, leaving only a few truncated Woodland features. Woodland features are likely present on the western portion of the site as well, but if present they may be too deeply buried in the thick late submember to have been exposed by plow-zone stripping. Of the three Woodland features, only two appear to be cultural in origin.

Feature 1

This feature consisted of a circular dark brown (10YR 3/3) stain with localized pockets of charcoal and burned soil (Figure 8.5). Eight lithic artifacts were recovered from the feature fill: five flake fragments, one biface flake, one secondary flake, and one piece of chert shatter. Forty-three microflakes were also found in the flotation sample. Botanical

remains include white oak wood charcoal, bark, and hickory nut shell. The size, shape, and contents indicate that Feature 1 probably represents a pit of undetermined function.

Feature 5

Feature 5 was a small circular stain with associated dispersed charcoal and burned soil. The only lithic artifacts were three microflakes identified in the flotation sample. Sorted botanical remains consist of 461 wood charcoal fragments and 17 bark fragments. A subsample analysis revealed a single wood species (maple) is represented. The evidence strongly suggests that this feature represents the remains of a burned tree root system.

Feature 16

This feature consisted of a small circular stain with dispersed charcoal, burned soil, and a light scatter of artifacts. It measured approximately 27 cm in diameter and exhibited a deep conical shape in profile (Figure 8.5). Eleven lithic artifacts were recovered from the feature: one tertiary flake, one flake fragment, one unmodified Burlington chert pebble, three unmodified sandstone fragments, and five microflakes. Botanical remains consist of 38 fragments of wood charcoal, one bark fragment, and one walnut shell fragment. A small subsample of 20 pieces of wood charcoal were all identified as hickory. The data appear to indicate that Feature 16 represents a large post.

Summary and Conclusion

Relatively few interpretations can be made regarding Woodland use of the Big Eddy site since nearly all diagnostic artifacts were recovered from disturbed contexts. Judging from the lack of pottery and cultivated plant remains and the low feature density, however, most of the Woodland occupations were probably relatively short-term, seasonal camps. Based on the sample of diagnostic artifacts, it appears that several different groups probably lived at the Big Eddy site during Woodland times, which lasted approximately 1,500 years. Kings Corner Notched points apparently are representative of the most common or primary Woodland component. Additional work in the upper portion of the thick late submember might help define this poorly understood component. Additional Woodland components may be represented by other corner-notched (e.g., Lander and Little Sac) and contracting-stemmed (e.g., Standlee and Gary) point types. Contracting-stemmed points with broad, rounded stems such as the Waubesa specimen are rare in the western Ozarks. The fact that it was manufactured from an exotic chert from eastern Kansas may indicate that a nonlocal Woodland component is represented at the Big Eddy site.

LATE ARCHAIC

Large basal-notched, square-stemmed, lanceolate, and expanding-stemmed points have been grouped by previous investigators in the Midwest into various artifact assemblages. These regionally defined complexes, however, often are characterized as having several interchangeable point types and other shared attributes. Many simply consist of groupings of the most common Late Archaic point types and other associated tools in the particular research area where they were defined. Regional examples in the Ozarks include the James River complex, the Sedalia complex or phase, the Booth assemblage, and the Titterington phase.

The James River complex was named for sites in the Table Rock Lake area in southwest Missouri by Chapman (1975:186). Several diagnostic point types such as Smith Basal Notched, Stone Square Stemmed, Table Rock Stemmed, and Afton Corner Notched were included in the complex. The Sedalia complex, as described by Chapman (1975:200–203) for northern and west-central Missouri, contains Sedalia Lanceolate, Smith Basal Notched, Stone Square Stemmed, Clear Fork Gouges, and Sedalia Diggers. In southwest-central Missouri, Robinson and Kay (1982:658–661, 1983:45) note the same assemblage with the addition of Etley Stemmed points and possibly Afton and Nebo Hill points. The Booth assemblage in northeast Missouri (Klippel 1969) consisted primarily of Etley, Stone Square Stemmed, and Sedalia Lanceolate along with diggers and gouges. Due to similarities between the Booth assemblage and the Sedalia complex, Chapman (1975:224) proposed the Sedalia phase to incorporate both. In western Illinois and extending into eastern Missouri, Cook (1976:67) defined another similar phase called Titterington following earlier descriptions of a distinctive mortuary complex by Titterington (1950) and Griffin (1952). Characteristic hafted bifaces of the Titterington phase are Etley and Sedalia points and Wadlow blades

(preforms). Associated radiocarbon dates indicate that all of these complexes occur between approximately 5000–2600 B.P.

None of the above gross artifact complexes are applicable to the Late Archaic materials discovered at the Big Eddy site, which vary significantly depending on specific stratigraphic context. On the central portion of the site (or east side of the stripped surface) where the late submember is very thin and overlaps the middle submember, several Late Archaic point types were found together (e.g., Smith Basal Notched, Stone Square Stemmed, Etley Stemmed, Castroville Corner Notched, and Afton Corner Notched). This finding suggests two possible scenarios: (1) multiple, successive occupations by people using varied point styles and occupying the site roughly contemporaneously; or (2) noncontemporaneous artifacts deposited on a very slowly aggrading or nonaggrading landform in which componency was mixed. In contrast, excavations in the thick, well-stratified late submember on the west side of the site revealed a separation of Late Archaic diagnostics into at least three separate components. One, characterized by large Smith Basal Notched and Etley Stemmed projectile points/knives, dates to early Late Archaic times. A second component that dates to middle Late Archaic times is represented by Williams Corner Notched points and is associated with a well-defined midden deposit. A third component appears to be late Late Archaic in age and is represented by thin, deeply corner-notched Afton and Castroville points. At least one other distinct Late Archaic point type (Table Rock Stemmed) was found at the Big Eddy site, but specific chronostratigraphic placement of this type was not possible because it was recovered from a disturbed context.

Smith-Etley Component

Smith Basal Notched (Figure 8.8a-g) was the most abundant early Late Archaic point type found with 16 specimens. Classic Smith points exhibit broad, straight to excurvate blade edges, short or long barbs extending nearly to the base, and a straight, squared stem. Most of the Smith Basal Notched points were found on the east half of the stripped surface (thin late Rodgers) during plow-zone removal. These are believed to have been bioturbated into the plow zone from the 2Ab horizon and/or from 10–30 cm immediately above the 2Ab horizon. This roughly correlates with the "lower component" reported by Schmits (1988:117) at approximately 80–110 cm bs. Schmits also recovered a Smith Basal Notched point, although it was found on cutbank slumpage. Two bulk carbon samples taken from the top (90–100 cm bs) and bottom (120–130 cm bs) portions of the 2Ab horizon in Block B yielded dates of 4497 ± 57 B.P. (Tx-9328) and 5158 ± 54 B.P. (Tx-9330), respectively (Table 7.1). This implies that the 2Ab horizon in Block B represented a relatively stable surface during early Late Archaic times.

Three Smith Basal Notched points were recovered from non-plow-zone deposits: two from cutbank slumpage and the other from Block A. As Block A was being stripped, one in situ Smith Basal Notched point was found in the southwest corner at a depth of 125 cm. Another large, broad, straight-sided distal-end fragment (probable Smith Basal Notched) was found at a depth of 120 cm in the east half of Block A. Both in situ artifacts were found in a dark, mottled, midden-like soil that comprised the westernmost extent of the buried 2Ab horizon and the sloping stream bank of the T1b surface. At this location, the 2Ab horizon was relatively thick, extending from approximately 115 cm to 185 cm bs.

Three square-stemmed points without barbs also were found on the eastern half of the stripped surface (i.e., thin late Rodgers Shelter submember). One of these was found in situ at a depth of 72 cm, embedded in the ramp descending into Blocks B-C. This was well below the plow zone and just above the 2Ab horizon. The stems of these specimens are straight and relatively broad with straight bases, and the blades are broad with straight to slightly convex edges (Figure 8.8f-g). These stem and blade attributes are identical to those of Smith Basal Notched points except for the absence of basal-oriented barbs. Some researchers classify these forms as Stone Square Stemmed; however, here they are classified as simply resharpened Smith Basal Notched points. Prehistoric resharpening and rejuvenation of the blade edges of these large cutting tools (resulting in barb removal) has caused some confusion in typing these specimens. For example, Marshall (1958:102) proposed two tentative square-stemmed types (i.e., Barry Square Stemmed and Stone Square Stemmed) for large knife-like forms from the Table Rock Lake area. He correctly noted that both are probably related, and that Stone Square Stemmed is often a reworked variety of Barry Square Stemmed (Marshall 1958:102, Figure 16). Chapman (1975:256–257), however, later used

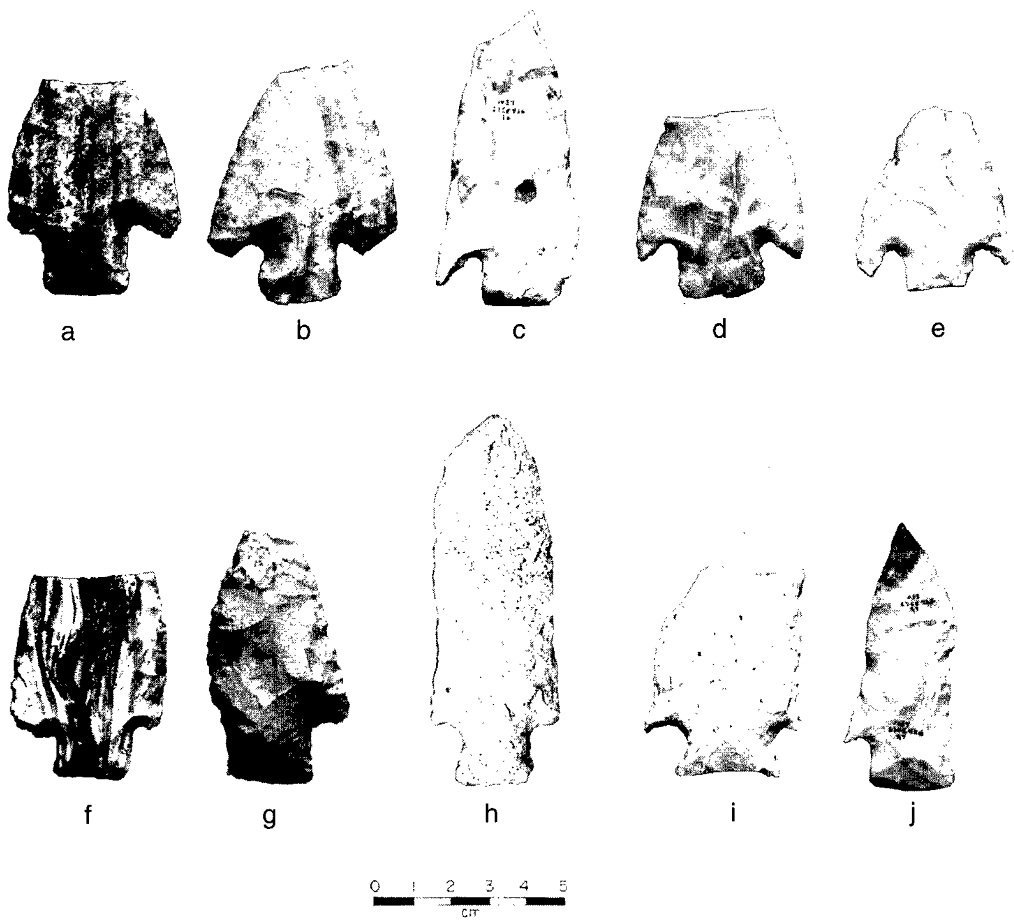


Figure 8.8. Early Late Archaic projectile points/knives: (a-e) Smith Basal Notched; (f-g) Smith Basal Notched minus barbs, "Stone Square Stemmed;" (h-j) Etley Stemmed.

Smith Basal Notched to refer to specimens retaining long barbs, and lumped Barry Square Stemmed into the Stone Square Stemmed type. O'Brien and Wood (1998:131) believe, probably correctly, that specimens with long recurved blades (see Chapman 1975:Figure A-24) found in northeast Missouri are probably Etley Stemmed variants.

The other large Late Archaic point type that appears to be associated (at least temporally) with the Smith Basal Notched points is Etley Stemmed. Unresharpened Etley points exhibit long recurved blades with or without short barbs and straight to expanding stems. Four Etley Stemmed points (Figure 8.8h-j) were found at the Big Eddy site—three from the plow-zone portion of the thin late submember and one from the 2Ab horizon of the middle submember. The latter point was excavated from the northwest corner of TU 2 (Block A) at a depth of 120 cm.

Two AMS radiometric dates are associated with the 2Ab horizon in Block A, which was located at the contact between the middle and late submembers. A small piece of charred hickory nutshell obtained from the same level in which the Etley Stemmed point (Figure 8.8h) was found in TU 2 (120–130 cm bs, the upper portion of 2Ab horizon) yielded a date of 4125 ± 45 B.P. (AA-29018) (Table 7.1). The other sample, a small piece of charred bark, was collected from the east wall of Block A at a depth of 160 cm (lower-middle portion of the 2Ab horizon). This sample yielded an age of 4130 ± 45 B.P. (AA-29020). These dates are slightly younger than the bulk carbon dates obtained from the 2Ab horizon in Block B approximately 50 m to the east;

however, this temporal discrepancy would be expected in a westward-prograding landform.

At this time, the nature of the relationship between Smith Basal Notched and Etley Stemmed points is unclear. Both are often found in the same occupational levels at sites in west-central and southwest-central Missouri (Chapman 1975; Kay 1983; Robinson and Kay 1982); however, Etley points are rarely found south of the Ozark Divide in extreme southwest Missouri and northwest Arkansas where Smith points generally dominate Late Archaic assemblages. The reverse is true for east-central and northeast Missouri. Both types are large and exhibit relatively crude percussion flaking; however, Smith blades are generally broad and excurvate, whereas Etley blades are long and recurved. The bases of both are stemmed, but one is straight or square stemmed while the other generally has an expanding stem (sometimes almost exhibiting corner notches). There are also preliminary indications of differential raw-material selection for the two point types. Given the important discrepancy in distributional ranges and differences in morphological attributes, as well as possibly functional and resource-selection differences, these two point types probably represent separate but related contemporaneous Late Archaic entities. If it assumed that they are representative of separate cultural groups, then the presence of these and other Late Archaic point types on the same stable alluvial surfaces or upland ridge tops may be attributed to contemporary, overlapping occupational ranges; similar subsistence and exploitation patterns; and/or socioeconomic activities such as planned rendezvous for material trade and kinship ties. Future excavations in a very rapidly aggrading context, such as that represented at the Big Eddy site by the thick late submember, offer the best potential for identifying discrete occupational components that will help determine whether Smith and Etley points are representative of a single cultural entity or if they are artifacts of contemporaneous but distinct groups.

In addition to the above diagnostic projectile points/knives, one Clear Fork biface (Figure 8.7l) was recovered during the excavations. It was found while stripping Block B at a depth of approximately 110–140 cm bs. This depth approximates the middle to lower portions of the 2Ab horizon of the middle submember. As a result, it represents the only Late Archaic artifact recovered from the middle submember in the central portion of the site. Based on stratigraphic context, it appears to be associated with the early Late Archaic (Smith-Etley) component. This heavy-duty bifacial tool has a strongly bevelled bit indicating that it was probably a woodworking tool such as an adze or celt (Turner and Hester 1993:246). It is not to be confused with the Clear Fork Gouge of the Sedalia complex, which is unifacially flaked and appears to have been used as a wood-scraping or planning tool (Chapman 1975; Seelen 1961, 1997). Unlike Clear Fork bifaces, Clear Fork Gouges exhibit a straight to convex unifacial working surface.

Features

Feature 17. This feature was discovered during trackhoe scraping in Block A (Figure 8.9) at a depth of 129 cm bs, which is in the upper portion of the 2Ab horizon in the middle Rogers Shelter submember. The feature was identified as a dark stain containing large chunks of wood charcoal. It was approximately 37 cm in diameter and extended to a depth of 141 cm. Eight lithic artifacts were recovered from the feature: seven fragments of burned siltstone and a flake fragment knapped from Burlington chert. Botanical remains from a flotation sample included 49 fragments of wood charcoal and charred bark and small bits of Juglandaceae nut shell. An analysis of 20 wood specimens revealed that a single wood species (ash) is represented. The evidence suggests that this feature represents the remains of a burned tree stump.

Feature 19. Feature 19 also was discovered by trackhoe scraping in Block A (Figure 8.9) (144–148 cm bs) slightly below the level of Feature 17. It consisted of a dark stain containing charcoal and rock fragments. In plan view, Feature 19 measured approximately 72 cm in diameter. The eastern portion of the feature appeared to have been bioturbated. The feature fill contained seven fragments of Northview siltstone, at least two of which were fire cracked. A flotation sample contained two microflakes and very small amounts of wood charcoal, bark, and Juglandaceae nut shell. This feature also appears to represent a burned tree stump. Most of the artifacts associated with this feature and Feature 17 probably represent incidental inclusions of residual early Late Archaic debris.

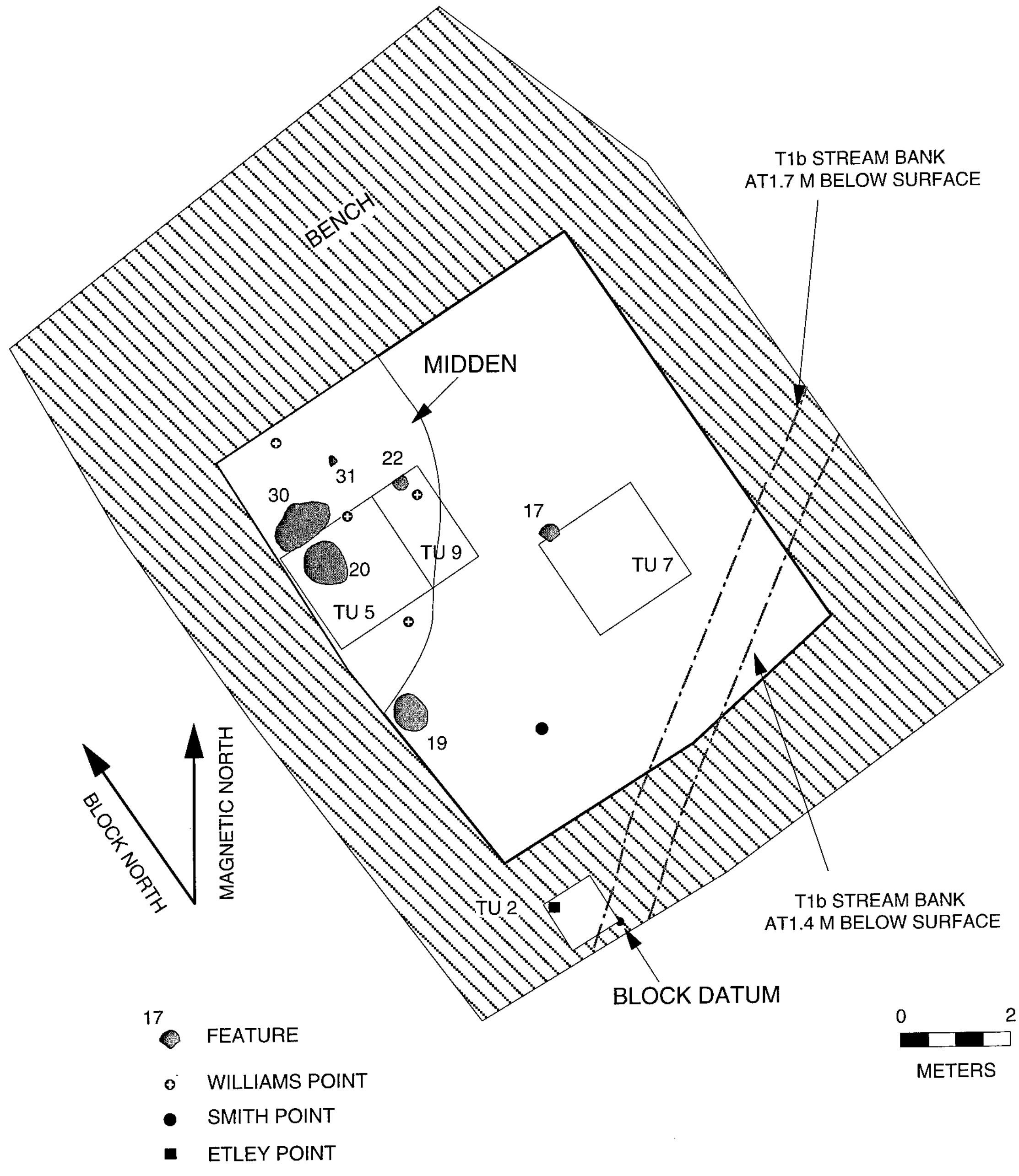


Figure 8.9. Test units, features, and Williams component midden deposit in Block A.

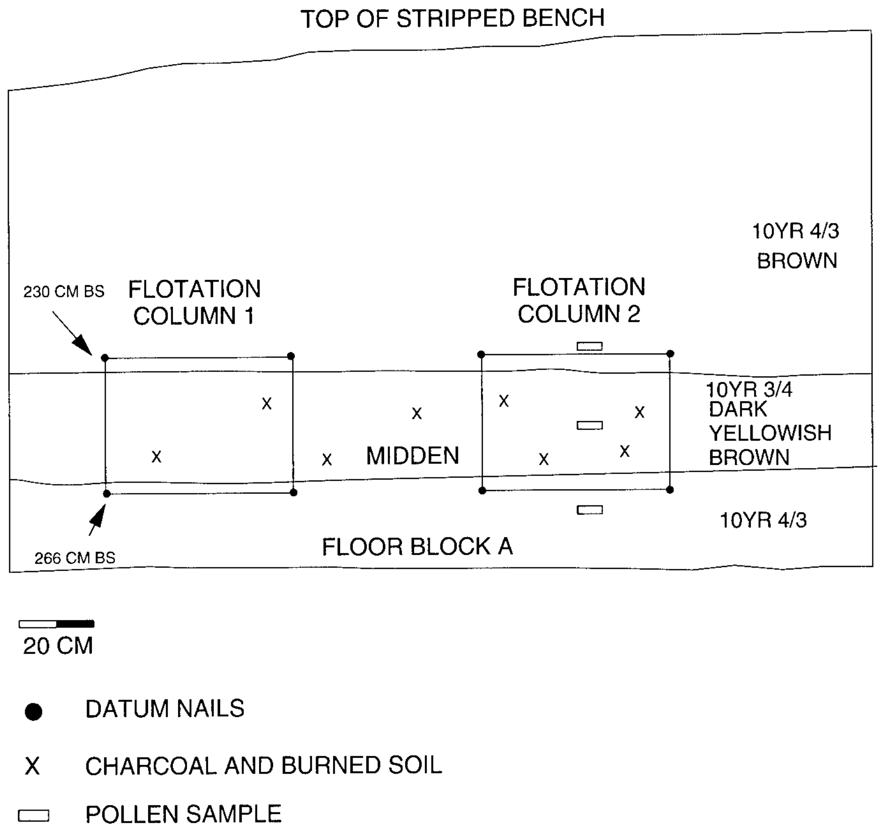


Figure 8.10. Profile of midden deposit in Block A (west wall of TU 5).

Williams Component

This component was restricted to a deeply buried and well-defined midden deposit encountered in the northwest corner of Block A at a depth of 233–263 cm bs (Figures 6.6, 8.9, and 8.10). It was situated in the middle portion of the thick late submember just beyond the T1b stream bank. Although found in deposits much deeper than the 2Ab horizon to the east, the midden and inclusive artifacts are slightly younger than those of the Smith-Eltey component. This is due to differences in landform occupation; the Smith-Etley occupants resided on the stable surface of the higher (and older) middle submember, whereas the occupants who produced the midden were living on a lower floodplain surface that was aggrading relatively rapidly.

Only the southeast portion of this midden, measuring 3.5 m east-west by 5.5 m north-south (14.8 m^2), was exposed in Block A (Figure 8.9). Assuming the midden feature is roughly circular, it is estimated that less than 20% of the midden was excavated, leaving over 60 m^2 of extant deposits to the north and west of Block A. The 30-cm-thick midden was dark yellowish brown (10YR 3/4) in color and had an ashy or greasy consistency. It contained abundant wood charcoal, charred nut shell, and burned soil, with moderate amounts of lithic debris and occasional calcined bone fragments. This midden was the only dense occupational deposit encountered in the late submember. It was also the only cultural deposit that yielded appreciable plant material (see Chapter 10) as well as some faunal remains and several ground-stone artifacts.

Two test units were excavated into the midden deposit (Figure 8.9). Test Unit 5 (2 x 2 m) was situated entirely within the midden, whereas TU 9 (1 x 2 m) cross-cut the southeast edge. The remaining portion of the midden area was repeatedly shovel skimmed. This work resulted in the definition of four features and the recovery of many lithic artifacts and large charcoal samples. Two charcoal samples from the middle and lower portions of the

midden deposit were submitted for radiocarbon analysis. Thirty grams of wood charcoal and nut shell from Level 25 (240–250 cm) of TU 5 yielded a date of 4040 ± 100 B.P. (Beta-112984), and approximately 7 g of nut shell from Feature 30 (252–260 cm) produced a date of 4020 ± 80 B.P. (Beta-109009). The two dates are remarkably close, indicating that the lower portion of the midden was deposited in a relatively short period of time. These dates roughly correspond with the middle portion of the Late Archaic period.

A total of 622 chipped-stone artifacts was recovered from the midden deposit (Table 8.1). Almost 600 of these represent flake debitage. Other artifacts include five corner-notched projectile points/knives that have been classified as Williams points (Figure 8.11) (Bell 1960:96; Suhm et al. 1954:490; Turner and Hester 1993:194–195). A sixth Williams point (Figure 8.12d) was found out of context on cutbank slump deposits derived from the late submember. Five of these Williams points are complete or nearly complete, whereas the sixth is a barb fragment. These corner-notched points exhibit broad blades, prominent barbs, expanding stems, and straight to convex bases. All of the points were finished with fine secondary and tertiary flaking across the entirety of each face. The characteristic flaking typically produced a biconvex cross-section with a maximum thickness range of 0.87–0.94 cm along the medial ridge.

Four of the Williams Corner Notched points with distal elements exhibit resharpening. At least one of these (Figure 8.11b) was intentionally resharpened to a prominent recurved and sharp distal end, a form that is often considered characteristic of Afton Corner Notched points. The similarity of recurved or pentagonal blade forms has led to considerable confusion in the classification of corner-notched Late Archaic points in the western Ozarks. Although generally similar in appearance, Afton and Williams points are significantly different in method of manufacture and probable function. This is amply illustrated by the comparison of Williams points recovered from the well-defined midden deposit with Afton points found at the site, as well as with Afton points recovered from the remarkable cache at Sulphur Spring, Oklahoma (Holmes 1903; Ray, personal observations at Smithsonian Institution 1998).

The primary difference is in flaking technology. True Afton points are wafer-thin (0.4–0.7 cm) and flat in cross-section; they almost certainly were knapped from thin flake blanks. Secondary and tertiary (pressure) flaking on Afton points is very systematic and invasive, with tertiary flake scars reaching more than halfway across the blade often at a diagnonally downward orientation. Williams points, on the other hand, are nearly twice as thick as Afton points, and the flaking is more random and less invasive, terminating at or before the midline, which produces the relatively thick biconvex cross-section. There are also significant differences in notching. For example, Afton points usually exhibit deep, narrow, corner to almost basal notches (Holmes 1903:247). The notches of Williams points, on the other hand, are generally shorter and wider and were made at a more acute angle with blunt antler tines. Finally, it appears that the characteristic pentagonally shaped blade on the two point types may have been produced by quite different processes. The recurved shape of Williams points was clearly produced by retouching the distal end, either during blade resharpening/tool maintenance or intentional recycling into a sharp piercing or etching tool. Suhm et al. (1954:490) first noted that Williams points were sometimes retouched to needle-like sharpness. Conversely, it appears that many Afton points were originally manufactured to a pentagonal form based on the many pristine examples in the large cache from Sulphur Springs, Oklahoma (Holmes 1903; O'Brien and Wood 1998).

Stages of Williams bifacial reduction are illustrated in Figure 8.12. Figure 8.12a-b are failed primary and secondary bifaces that were recovered from the midden. They represent early and middle reduction stages prior to a finished product (Figure 8.12c-d). Heat treatment was a very important and early part of the reduction sequence in the manufacture of Williams bifaces (see Chapter 9). Preforms may even have been subjected to repeated heat treatments in successive primary and secondary stages. In contrast, heat treatment appears to have been less integral to the production of Afton Corner Notched points.

Non-chipped-stone artifacts recovered from the Williams component consist of shatter, fire-cracked rock, unmodified manuports, groundstone tools, and iron ore fragments (Table 8.2). Shatter is mostly comprised of Burlington chert and may represent unsuccessful heat treatment or nodule fracture along incipient planes during lithic reduction. Fire-cracked rock is composed of a variety of raw materials including Northview siltstone, Burlington chert, and sandstone from the Jefferson

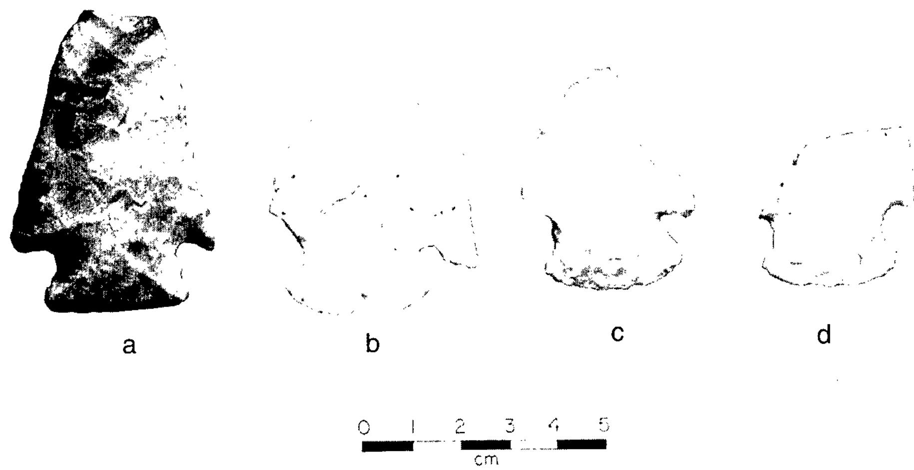


Figure 8.11. Williams Corner Notched projectile points/knives.

Figure 8.12. Artifacts from the Williams component: (a) primary biface reduction failure; (b) secondary biface reduction failure; (c-d) finished Williams points; (e) scratched hematite; (f) grooved hematite; (g) unmodified hematite; (h-i) unmodified limonite.

City and Warner formations. Manuports are comprised of similar materials, most of which probably represent unbroken heated rocks. Based on the quantity of charred nut shell in the midden deposit, hickory-nut processing was a major activity at the site. One ground-stone tool, a multipurpose mano/nutting stone/anvil stone/hammerstone, was recovered from the midden deposit. In addition, two other multipitted nutting stones recovered from the Block A backdirt probably are affiliated with the Williams component.

Another major activity represented in the Williams assemblage appears to have been the production of red and yellow ochre from chunks of hematite and limonite (Figure 8.12e-i). Fourteen pieces of hematite and four chunks of limonite were recovered from the midden deposit. All of the iron ore probably was collected from residual deposits of Pennsylvanian strata. The raw iron ore appears to have been processed by two methods: rubbing the material on an abrader or metate producing one or more faceted surfaces and scratching or etching the material with a sharp tool producing linear grooves and striations. One unusual piece of hematite (Figure 8.12f) exhibits a fluted surface 1.24 cm wide and at least 0.34 cm deep; it appears to have been used repeatedly to coat cylindrical objects of small diameter, such as dart or spear shafts.

Features

Feature 18. This feature was discovered in the south wall of Trench 1 at a depth of 234–247 cm bs in the middle portion of the late submember. The feature appeared in profile as an irregular ellipse and extended approximately 20 cm into the trench wall. A rodent burrow was identified on the upper surface but did not extend into the feature. Feature 18 contained a dispersed lens of charcoal with scattered bits of burned soil, two fragments of fire-cracked Northview siltstone, two tertiary flakes, and one flake fragment. A flotation sample yielded an appreciable amount of wood charcoal and one Juglandaceae nut shell fragment. The purpose or function of this diffuse feature is unclear; however, it appears to be associated stratigraphically with the Williams component identified in Block A located approximately 30 m to the south. That is, it is located at the same depth in the late submember as the Williams component midden and features.

Feature 20. This feature consisted of a concentration of burned soil, charcoal, and hematite powder discovered in the northwest quadrant of TU 5 (Figure 8.9). It was found in the lower portion of the Williams midden deposit at a depth of approximately 245–255 cm bs. In plan view, the main concentration within the feature measured approximately 70 cm in diameter, although more dispersed deposits extended into the northeast and southwest quadrants of TU 5. Burned (oxidized) soil and charred hickory nut shell fragments were concentrated in the west half of the feature, whereas pockets of processed hematite or red ochre were concentrated in the east half. The feature was poorly defined in cross-section. Two rodent burrows bisected the feature, but they were clearly defined and easily separated from feature fill. A total of nine lithic artifacts was recovered: one secondary flake, two tertiary flakes, two biface flakes, and four flake fragments. Two flotation samples (9 liters from each half) were collected from Feature 20; they yielded wood charcoal, bark, hickory nut shell, Juglandaceae nut shell, acorn shell, rhizome tissue, and 49 microflakes. The physical attributes and contents of this feature suggest that it is either a dispersed hearth or dumped hearth fill within the midden. The associated pockets of processed hematite powder appear to support the latter interpretation.

Feature 22. Feature 22 was discovered in the northern portion of TU 9 approximately 1.5 m east of Feature 20 (Figure 8.9). Like Feature 20, it was situated in the lower portion of the Williams midden deposit at a depth of 240–253 cm bs (Figure 8.5). Feature 22 is very similar to Feature 20 in content but is smaller in size, measuring only about 25 cm in diameter. It exhibited a concentration of burned soil and charred hickory nut shell as well as a pocket of processed hematite. Four lithic artifacts were recovered: one biface thinning flake, two pieces of chert shatter, and one fragment of sandstone. A flotation sample yielded a large amount of hickory nut shell, acorn shell, wood charcoal, bark, and 19 microflakes. This feature appears to represent redeposited hearth fill within the middle Late Archaic midden.

Feature 30. This feature was discovered while shovel skimming in the Williams component midden on the north side of TU 5 (Figure 8.9). It was situated in the lower portion of the middle Late Archaic midden at 252–260 cm bs. The feature was roughly oval in plan view and lenticular in cross-section (Figure 8.5). Feature contents consisted primarily of a concentration of carbonized hickory nut

shell with scattered bits of charred wood, burned soil, calcined bone, and a small number of lithic artifacts: one secondary flake, one biface flake, one flake fragment, two pieces of chert shatter, and one piece of fire-cracked rock. Botanical remains include wood charcoal, hickory nut shell, and acorn shell. A 7–10-g sample of charred nut shell from Feature 30 was submitted for radiocarbon analysis, yielding a date of 4020 ± 80 B.P. (Beta-109009). This feature appears to represent a concentration or refuse dump of charred hickory nut shell mixed with other midden debris.

Feature 31. This small feature was also found while shovel skimming in the midden area north of TU 5 and 9 (Figure 8.9). It was situated at the base of the Williams component midden at approximately 261–262 cm bs. The feature was irregularly shaped and measured approximately 14 cm by 16 cm. The contents of Feature 31 were similar to the other features: charred nut shell and small pockets of processed hematite. The only lithic artifact found during the hand excavation of Feature 31 was one secondary flake knapped from Burlington chert. The entire feature fill (2.5 liters) was processed as a flotation sample; it yielded wood charcoal, bark, hickory nut shell, acorn shell, and two microflakes. This feature also appears to represent a concentrated pocket of refuse within the larger midden deposit.

Faunal Material

Several small bone fragments were recovered from the midden deposit in Levels 24 and 25 in TU 5. All of the bone, however, is calcined and poorly preserved (highly weathered and extremely friable). As a result, the bone fragments could only be tentatively classified as indeterminate medium-to-large-sized mammal (see Appendix 2 for details). Archaeobotanical remains, which were more common in the midden deposit, are discussed at length in Chapter 10.

Afton-Castroville Component

Two point types not affiliated with the Smith-Etley component or the Williams component are Afton Corner Notched (Figure 8.7i-j) and Castroville Corner Notched (Figure 8.7g-h). The definition of this component is based on disparate technological attributes (noted above) and stratification. Unlike the thick and crudely percussion-flaked, broad-bladed Smith and Etley points and the relatively thick, randomly flaked Williams points, Afton and Castroville points are thin, flat in cross-section, and exhibit exquisite systematic secondary and tertiary flaking.

The Afton point type was named by Bell and Hall (1953) based on numerous pristine specimens recovered from a spring cache in northeast Oklahoma (Holmes 1903). This remarkable cache of points appears to represent an offering of 1,000 or more artifacts, many of which were complete projectile points (Holmes 1903:244–245). Although there is considerable morphological variation among the points found in the cache (Holmes 1903:Plates 10–15), most are very thin in cross-section and exhibit fine bifacial flaking and deep, narrow corner notches (personal observations of Afton specimens in Smithsonian collection). An antler tool kit was also found with the cache. It included small antler batons probably used for fine secondary trimming and split antler tines (Holmes 1903:247, Plates 24 and 25) that were used to make the deep, narrow notches. It is probable that most of the Afton points in this cache were made by a small group of related knappers during a short period of time.

The distinction between Afton points and Castroville points is a small one, but there appear to be two subtle differences. Afton points exhibit very fine secondary and tertiary flaking over entire faces resulting in the obliteration of earlier percussion flake scars. Tertiary, or pressure, flaking is highly controlled and systematic with a parallel or diagonal patterning. Late-stage flaking of Castroville points, on the other hand, appears to be more random and less thorough with the retention of earlier broad (percussion) thinning scars. Afton points are also slightly thinner in cross-section, having a thickness range of approximately 0.50–0.65 cm compared to 0.70–0.77 cm for Castroville. Nevertheless, judging from individual variations in the cache of Afton points from Oklahoma, it is certainly possible that the relatively subtle differences between Castroville and Afton noted here could simply represent a range of knapping variability, such as that between apprentice and accomplished knappers. The above differences could also simply be related to specimen size, with better flaked, thinner points classified as Afton and larger points classified as Castroville. At a minimum, both types are representative of highly skilled knappers who produced very thin hafted bifaces. More work on the

Afton-Castroville component in the late submember should help determine whether this component is represented by two closely related point types or simply by the range of variability within the Afton type.

Three Castroville points and four Afton points were recovered from the Big Eddy site. Unfortunately, most of these were from disturbed contexts (e.g., plow zone, cutbank slumpage, and gravel bars). One Castroville point fragment, however, was recovered in situ from the late submember at a depth of approximately 150 cm bs. It was found while scraping the west end of Trench 2, which is well west of the middle submember (T1b) stream bank (Figure 7.1). Unfortunately, no controlled excavations were conducted in this portion of the late submember. This was primarily because the time-stratigraphic relationship between the middle and late submembers was not well understood until later in the project. As a result, hand excavations conducted in the late submember were above (TU 1) and below (TUs 5, 7, and 9) the Afton-Castroville component, and those conducted at elevations equivalent to the Afton-Castroville horizon occurred in TU 2 located on the stream bank of the middle submember. No radiocarbon samples were recovered from the upper-middle portion of the late submember; however, the stratigraphic position of the Castroville point in the late submember approximately 80–110 cm above the midden deposit in Block A clearly indicates that it postdates the Williams component.

The temporal affiliation of Afton points is somewhat unclear; suggested ages range from early Late Archaic to Late Woodland (O'Brien and Wood 1998:147). This is probably due to at least three factors: (1) the misidentification of other Late Archaic points (e.g., resharpened Williams and recurved Etley) as Afton, (2) the recovery of Afton points from mixed deposits in sheltered sites, and (3) the rare occurrence of true Afton points in well-stratified, dated contexts. As O'Brien and Wood (1998:163) point out, the only places where Afton points have been found in quantity are the cache at Sulphur Spring in northeast Oklahoma (Holmes 1903) and the Holbert Bridge Mound in southwest Missouri (Wood 1961). Unfortunately, no radiocarbon dates were obtained from either site.

Chapman (1975:241) suggested a broad range of 5000–2000 B.P. for Afton points, whereas O'Brien and Wood (1998) suggest a more narrow range of 3700–2600 B.P. Kay (1982e:462–463, 547) described four true Afton points obtained primarily from the lower portion of Stratum 4 at Rodgers Shelter, which he placed in a Late Archaic complex dating approximately 3600–2300 B.P. Two Afton points recovered from Strata II and III at John Paul Cave in Christian County, however, appear to be associated with Middle Woodland points (Ray 1995b:40). In sum, most of the evidence appears to indicate that Afton Corner Notched points are terminal Late Archaic in age but possibly extend into Middle Woodland times. Castroville points appear to be associated with a similar time frame of approximately 2800–2400 B.P. (Turner and Hester 1993:86). Future work in the thick late submember at the Big Eddy site can potentially clarify the temporal association of Afton and Castroville points. In the meantime, a terminal or late Late Archaic age is assigned to the Afton-Castroville component at Big Eddy based on stratigraphic position relative to other diagnostic artifacts and radiocarbon-dated strata.

Unassociated Late Archaic Diagnostic

One other diagnostic Late Archaic point was recovered from the Big Eddy site, but it could not be associated with the cultural components delineated above due to lack of context. It is a Table Rock Stemmed point (Figure 8.7k); however, judging from the primary (unfinished) flaking and transverse break, it actually represents a Table Rock preform failure. It was discovered in cutbank slumpage from the late submember at the west end of the site. Although Table Rock Stemmed points are often found in association with other Late Archaic points in southwest-central Missouri (e.g., Smith Basal Notched and Etley Stemmed), it is probably representative of a distinct cultural component. Table Rock Stemmed points exhibit a characteristic unique to Late Archaic points—a heavily ground stem and base. It also has a distributional range that differs somewhat from Smith and Etley points, but especially Etley points. The core area of Table Rock Stemmed points is south of the Ozark Divide in southwest Missouri and northwest Arkansas, whereas Etley points occur primarily in central and northeastern Missouri. Smith points can also be found in central portions of Missouri, but they are most common in southwest Missouri, northwest Arkansas, and northeast Oklahoma (Chapman 1975:256).

Summary and Conclusion

Aside from the unprecedented early prehistoric discoveries made at Big Eddy (described later), the site is very important because it contains a number of stratified Late Archaic horizons with dateable deposits. Three separate components were identified and related to specific stratigraphic contexts, and the site potentially contains at least one other component yet to be associated with a stratigraphic horizon. In the central portion of the site, most of these Late Archaic components form a palimpsest deposit associated with the T1b surface, the youngest increment (40 cm thick) of the middle submember modified by the 2Ab horizon of Buried Soil 2, and the overlying thin (30 cm thick) late submember. Bulk carbon samples dated the 2Ab horizon in this portion of the site to approximately 5150–4500 B.P. Additional work in this area with mixed Late Archaic deposits would yield little valuable cultural-stratigraphic data. A greater potential for interpreting Late Archaic stratigraphy occurs in the much thicker mid-late Holocene alluvium on the west side of the site. At this location, the late submember is over 4.0 m thick. Here, it aggraded at a relatively rapid rate, sealing individual cultural components. Future work in this portion of the site may refine or redefine broad, overly inclusive complexes (e.g., James River and Sedalia complexes) into a series of discrete, contemporaneous or successive Late Archaic components.

The oldest delineated Late Archaic component at Big Eddy is represented by large, heavy-duty hafted cutting tools such as Smith Basal Notched and Etley Stemmed. Unfortunately, test excavations in strata containing this component yielded few other associated artifacts or archaeobiological remains. Both point types were found in the upper portion of the 2Ab horizon (120–130 cm bs) on the west side of the site near the contact between the middle and late submembers. Two radiocarbon dates of approximately 4130 B.P. are directly associated with the Smith-Etley component and the 2Ab horizon at this location. These dates are slightly earlier than those obtained by Kay (1982d) at Rodgers Shelter. Other radiocarbon dates associated with Smith Basal Notched points in southwest Missouri, however, are in line with those from the Big Eddy site. For example, Haynes (1985:14) reports a Smith point found slightly above material dating 4585 ± 130 B.P. and a Smith point found slightly below material dating 3680 ± 100 B.P. in the Pomme de Terre River valley; Kay (1983:50) reported at least three >4000 B.P. dates from Phillips Spring; and Ray (1995b:14, 1997:18–19) found two Smith points in a well-defined stratum that dated to 4660 ± 70 B.P. at John Paul Cave in Christian County. It appears, then, that the Smith-Etley component at the Big Eddy site dates to early Late Archaic times. The location of Smith and Etley points in the thick late submember (presumably below 260 cm and the Williams component) by future investigations could determine whether these two point types were made by the same cultural entity, or whether Smith and Etley points actually were produced by contemporaneous but separate cultural groups.

More extensive excavations were associated with the second Late Archaic component. This component contained a much larger assemblage of artifacts, as well as significant archaeobotanical remains. This component was discovered deeply buried in the rapidly aggrading late submember (230–260 cm bs), resulting in an isolated or sealed cultural deposit. This lithic assemblage is represented by a single diagnostic point type, Williams Corner Notched. The Williams occupation produced a dense midden deposit approximately 30 cm thick containing rich archaeobotanical remains, lithic debris, and other artifacts. Two radiocarbon dates obtained from the lower portion of the midden yielded middle Late Archaic dates of just over 4,000 years old. Based on the development of a thick midden and the presence of possible cultigens (e.g., chenopod), it appears that the Williams component probably represents multiseasonal if not year-round occupation(s).

The third Late Archaic component is represented by Afton and Castroville corner-notched points. The distinction between the two deeply corner-notched points is limited, and the minor differences could be a result of a range of variation in the skills of the flintknappers. Unfortunately, only one Castroville point was found in an undisturbed context in the late Rodgers Shelter submember. Although no radiocarbon dates were obtained for this component, it is located substantially above the Williams component. It is considered to be late Late Archaic in age, possibly extending into Woodland times.

Finally, at least one other Late Archaic point type, Table Rock Stemmed, is represented at the site. It was not found in stratigraphic context; how-

ever, based on radiocarbon dates from other sites in the Ozarks, it is probably associated with the early-middle portion of the Late Archaic period. More extensive research needs to be conducted in the late submember on the west side of the site in an attempt to delineate each Late Archaic component chronostratigraphically.

MIDDLE ARCHAIC

The 1997 investigations resulted in the recovery of relatively few artifacts and only one feature that appear to be associated with the Middle Archaic period. Based on extrapolation from the radiocarbon-dated strata, the Middle Archaic period is represented in the lower portion of the upper half of the middle submember, or approximately 130–180 cm bs.

This horizon was investigated by careful trackhoe scraping in Block B during which only a light scatter of Middle Archaic artifacts was found. These consisted of one primary biface, one secondary biface, two utilized flakes, two secondary flakes, four biface flakes, three flake fragments, and three ground-stone artifacts. The ground-stone artifacts are one grooved sandstone abrader and two faceted (or flat) sandstone abraders. All three abraders were thoroughly coated with red ochre. Unfortunately, these ochre-stained abraders were not found in situ, and their association with the processed deposit of hematite (Feature 21) discussed below is unclear. Nevertheless, these ochre-stained ground-stone tools and the processed-ochre deposit found between 130 and 180 cm bs indicate that hematite processing was a significant activity at the Big Eddy site during this time. Hematite (processed pigment) apparently was an especially important commodity during the Middle Archaic period in southwest Missouri (McMillan 1976a:225). Raw hematite ore is locally available as residual deposits in upland locations and in stream deposits of bottomland areas.

No diagnostic Middle Archaic artifacts were found during the excavations. Future work at the Big Eddy site should include more extensive and controlled excavations in the mid-Holocene deposits of the middle member. Although there are indications that the Middle Archaic occupation was relatively short term, additional detailed work could shed more light on specialized adaptations to the hot, dry (Hypsithermal) climatic conditions in the Sac River valley.

Features

Feature 21

This feature was discovered during trackhoe scraping in Block B at a depth of approximately 170 cm bs. Stratigraphically, it was situated in the lower portion of the upper half of the middle submember. It consisted of a circular, weak red (10R 4/4) stain measuring approximately 18 cm in diameter. In profile it was round to conical in shape and it measured 16 cm in depth (Figure 8.5). The red staining was concentrated at the center of the deposit (10 cm diameter) and became diffuse toward the edges. No artifacts were directly associated with this feature; however, it is probable that the three above-mentioned hematite-stained abraders found in the backdirt are related to it. Two similar but larger hematite-processing features (i.e., masses of powdered hematite) with associated hematite-stained abraders were discovered in Middle Archaic levels at Rodgers Shelter (Ahler and McMillan 1976:195)

A flotation sample measuring 7.5 liters was collected from Feature 21. It yielded numerous small (1–2 mm) particles of ground hematite but little else. The results indicate that this feature consisted of a concentrated deposit of processed hematite (i.e., hematite powder), possibly cached in a small pit.

EARLY ARCHAIC

Several distinct Early Archaic points have been found at the Big Eddy site. Unfortunately, most of these were found out of context on cutbank slumpage or in nearby gravel deposits. Nevertheless, the general age of most of these points is known from other large-scale excavations in the Pomme de Terre River valley (Kay 1982e; Wood and McMillan 1976) and at other locations in southwest Missouri (Chapman 1975; O'Brien and Wood 1998). In addition, many of the Early Archaic diagnostic artifacts found at Big Eddy are the same as those recovered from the nearby Montgomery site (Collins et al. 1983), which yielded numerous Late Paleoindian and Early Archaic point types (Figure 8.13).

Schmits (1988:Figure 24) illustrates four Early Archaic projectile points/knives that Aaron Brauer collected from the Big Eddy cutbank during the early 1980s. They are one Jakie Stemmed (Figure 8.14f), one Rice Lobed (Figure 8.14g), one Searcy (or

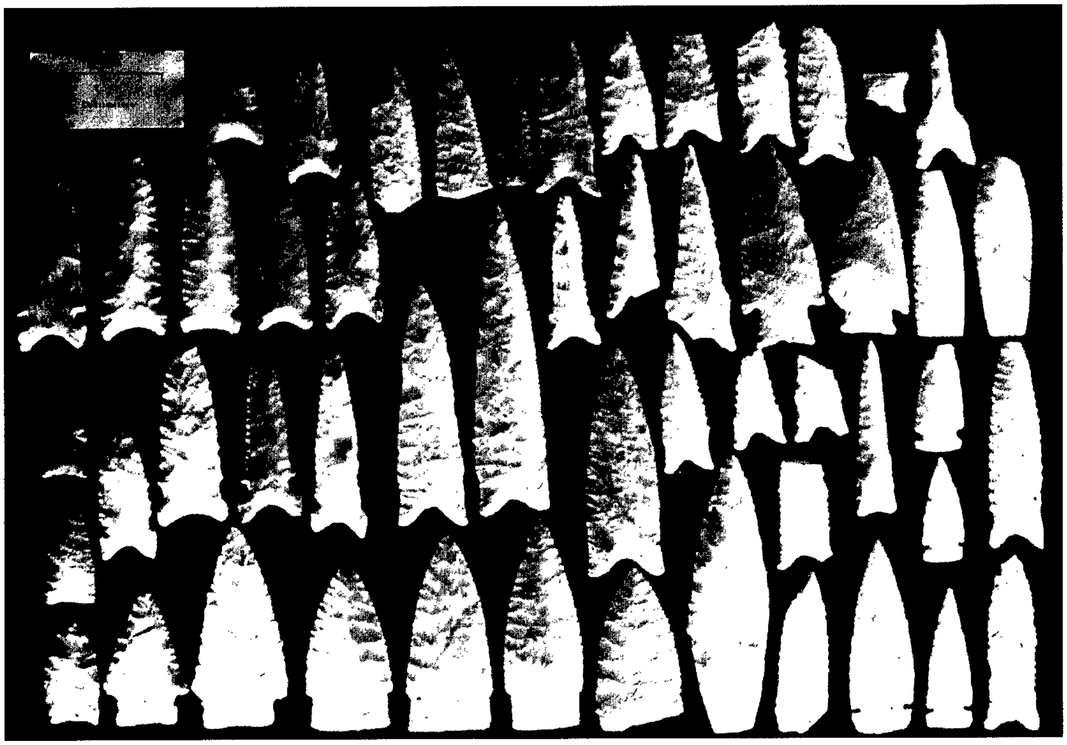


Figure 8.13. Late Paleoindian and Early Archaic projectile points/knives from the Montgomery site, 23CE261 (photo courtesy of Charles D. Collins).

Rice) Lanceolate (Figure 8.14j), and one unidentifiable blade fragment. The Searcy Lanceolate and the unidentifiable blade fragment were recovered in situ midway down the bank at approximately 210 cm bs (Aaron Brauer, personal communication 1998). Based on our chronostratigraphic sequence, this would place them in the (late) Early Archaic deposits within the middle submember.

Several other private collectors have found Early Archaic artifacts at the Big Eddy site. A. Clark Montgomery has recovered one Cache River Side Notched point (Figure 8.14e) on cutbank slumpage and a Hidden Valley (or Rice Contracting Stemmed) point (Figure 8.14b) in situ in the cutbank at a depth of 180 cm. Although the Hidden Valley specimen is fragmentary, it exhibits a moderately bevelled blade and extensive grinding along both sides of the stem. Terry McCurdy also found seven Early Archaic points in disturbed contexts along the south and west sides of the site (i.e., cutbank slump, eddy pool, and gravel bar): one Packard point (Figure 8.15a), two Searcy points (Figure 8.14k-l), one Hidden Valley point, one Graham Cave point (Figure 8.14h), one Cache River point (Figure 8.14m), and one St. Charles-like point (Figure 8.14i). It is interesting to note that one Searcy point found by McCurdy in the deep eddy pool (at a depth of about 2.4 m) exhibited a dark substance along three step fractures located in the haft area. If O'Brien and Wood (1998:117) are correct that Searcy points were placed in socketed foreshafts, this dark substance could be pine pitch or other resin used to hold the point in place. The introduction of the point into the deep, cold waters of the eddy pool soon after being eroded from context may have helped preserve this substance.

Several other Early Archaic artifacts were collected by Dan Long, Charlie Collins, and Terry Collins from cutbank slumpage along the south side of the site in the mid 1980s. These include four Packard points (Figure 8.15b-e) and one Graham Cave point (Figure 8.15f). In addition to the above artifacts found by private individuals, Ziegler (1994:48) reported finding four points on cutbank slumpage during archaeological inventory and monitoring downstream of Stockton Lake. These consisted of one Graham Cave point, one Jakie Stemmed point, and two unidentified side-notched points with

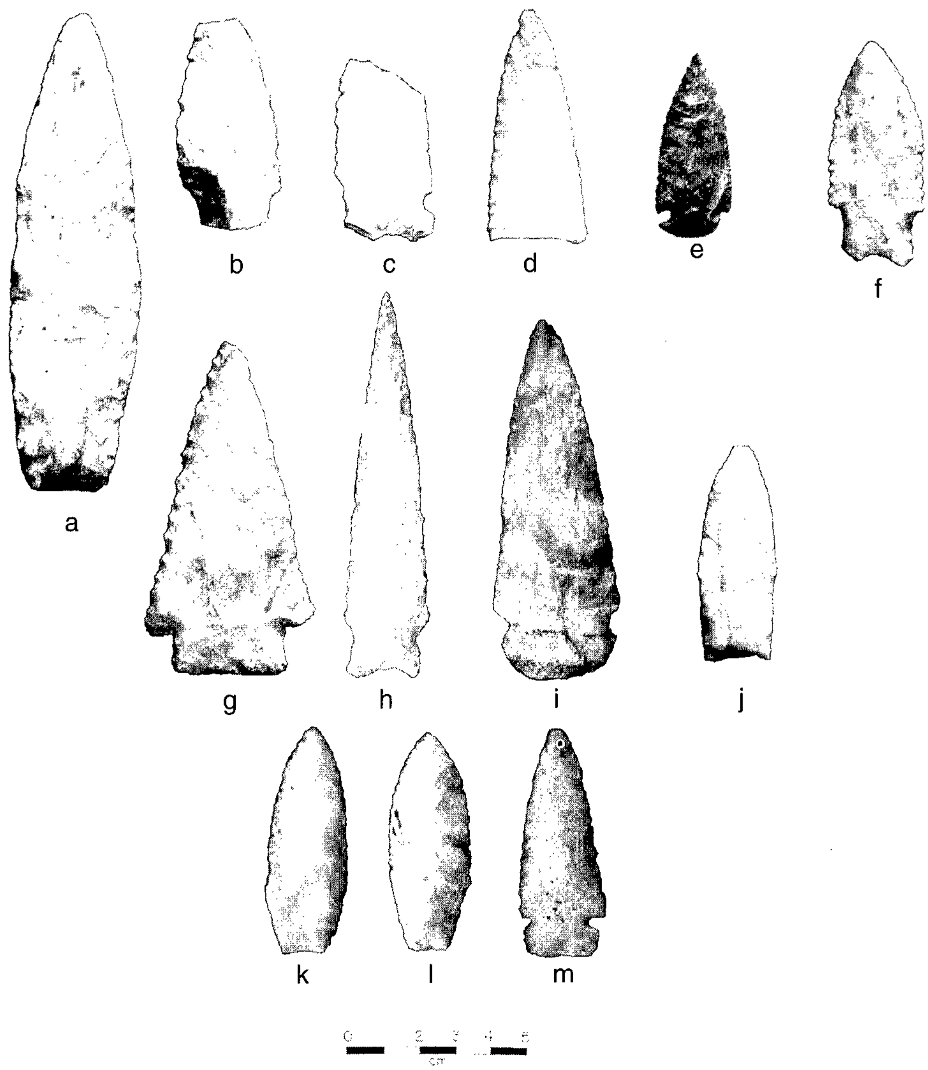


Figure 8.14. Early Archaic hafted bifaces: (a) nondiagnostic preform; (b) Hidden Valley Contracting Stem; (c) Graham Cave Side Notched; (d) unidentifiable distal end fragment; (e) Cache River Side Notched; (f) Jakie Stemmed; (g) Rice Lobed; (h) Graham Cave Side Notched; (i) St. Charles-like; (j-l) Searcy Lanceolate; (m) Cache River Side Notched.

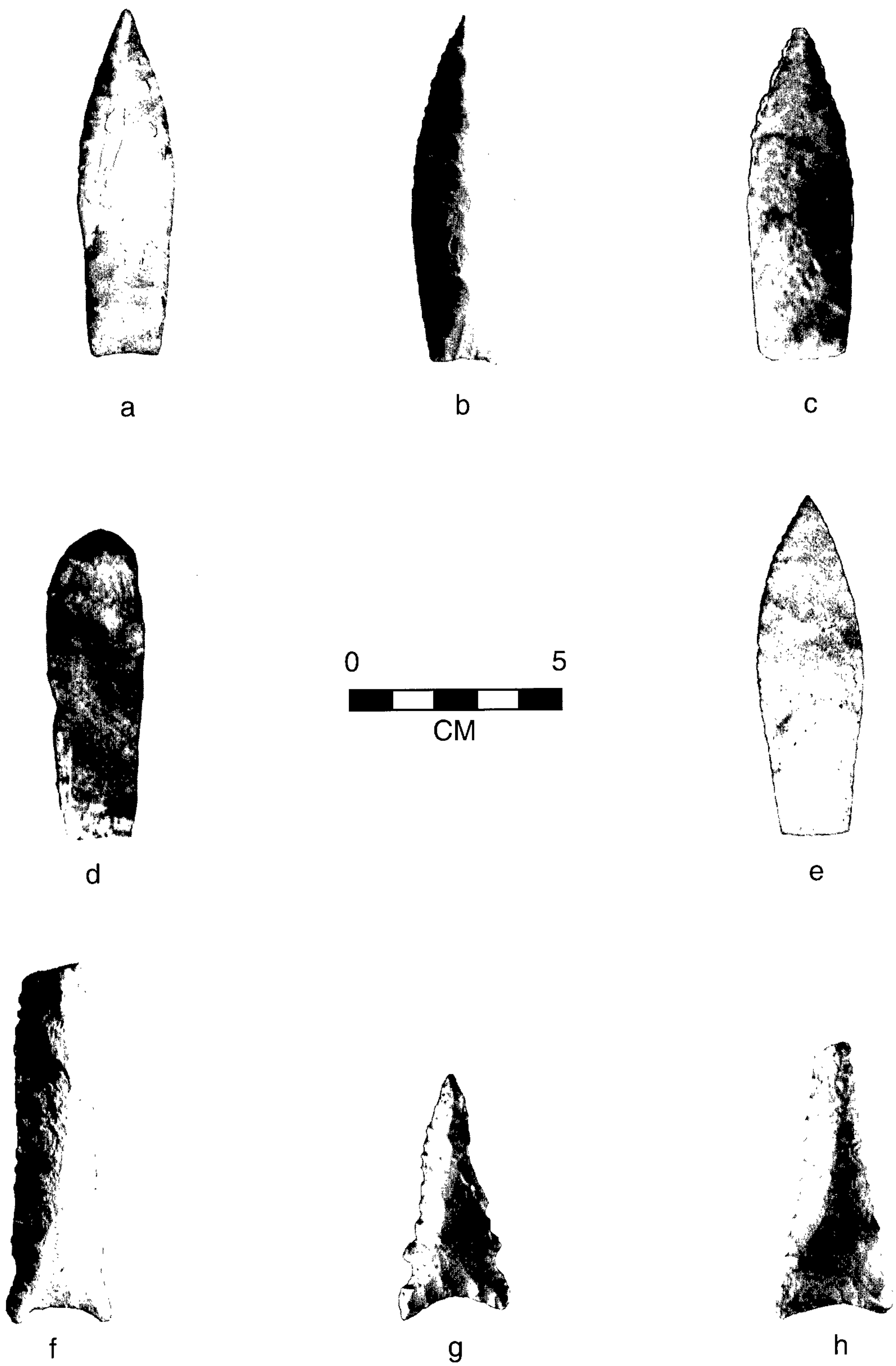


Figure 8.15. Late Paleoindian/Early Archaic projectile points/knives: (a-e) Packard Lanceolate; (f-h) Graham Cave Side Notched.

straight to slightly concave bases. These points were unavailable for study.

The Early Archaic period is represented within approximately 100 cm of overbank alluvium forming the lower half of the middle submember. The thickness of the Early Archaic cultural deposits is nearly equal to the combined thickness of the Middle Archaic and Late Archaic cultural deposits. Although the stratigraphic break is tentative, it appears that the thick Early Archaic deposits at Big Eddy can be divided into late Early Archaic (180–240 cm) and early Early Archaic (240–280 cm) components. This division is based primarily on two dates (8190 ± 60 B.P. [AA-29019] and 9525 ± 65 B.P. [AA-27479]) obtained from the middle and lower portions of the middle submember (Table 7.1). An extrapolation of the intervening 61 cm of alluvial sediments yields an average overbank sedimentation rate of approximately 0.5 mm/year.

Late Early Archaic Component

The only controlled excavations in late Early Archaic deposits were in TU 3 located on the south side of Block B. This unit, which was screened from 180–230 cm bs, yielded only six flakes. A few additional late Early Archaic artifacts were recovered during trackhoe scraping in Block B. These consist of 17 flakes, one core, one primary biface, one secondary biface, one drill, one fire-cracked rock, one sandstone metate fragment, and one projectile point. The projectile point is a Graham Cave Side Notched (Figure 8.15g) found in situ in the east half of Block B at a depth of 219 cm. It exhibits a moderately (left) bevelled and serrated blade. Two other diagnostic artifacts that appear to be associated with the late Early Archaic component are the Hidden Valley point fragment (Figure 8.14b) found by A. Clark Montgomery in situ in the cutbank at 180 cm bs and a Searcy point (Figure 8.14j) estimated by Brauer to have been found at 210 cm bs.

Two other probable Graham Cave points may be affiliated with the late Early Archaic component. One is a strongly bevelled midsection that was found out of context on the cutbank. The other is a side-notched point with a long, parallel-sided, slightly (right) bevelled blade (Figure 8.14c). Unfortunately, it was found on Block B backdirt exhumed between 180 and 260 cm bs. As a result, it is Early Archaic, but it cannot be definitely associated with the early or late subdivisions. Its physical attributes, however, appear to be intermediate between classic, steeply bevelled Graham Cave points and later, nonbevelled White River points. If so, it probably was derived from the late Early Archaic deposits. Two radiocarbon samples obtained from a cave stratum in Christian County containing Graham Cave and Searcy diagnostics yielded uncalibrated ages of 7160 ± 180 B.P. and 7540 ± 90 B.P. (Ray 1997:36).

Early Early Archaic Component

A larger sample of early Early Archaic artifacts was collected during the project. This sample was obtained during the hand excavation of 16 m^2 from 250–280 cm bs in Block B and 1 m^2 from 240–280 cm bs in Block D. Non-chipped-stone artifacts recovered from early Early Archaic levels included chert shatter, fire-cracked rock, and two faceted abraders (Table 8.2). Most of the early Early Archaic chipped-stone artifacts consist of flake debitage (Table 8.1); however, several recovered tools are noteworthy. One large secondary biface over 13 cm long (Figure 8.14a) was found at a depth of approximately 240 cm during trackhoe stripping. This artifact appears to be an unfinished preform for some large Early Archaic projectile point/knife, possibly a Searcy Lanceolate. One distal-end fragment of a tertiary biface (Figure 8.14d) was discovered in TU 11 at a depth of 253 cm. This specimen exhibits well-executed parallel flaking and a fine serrated edge; it is from a finely crafted early Early Archaic projectile point/knife that appears to have been broken during use.

The only diagnostic artifact recovered from early Early Archaic context is a Graham Cave Side Notched point (Figure 8.15h) found at the east end of Trench 2 at a depth of 262–268 cm bs. This point was manufactured from a mottled brown chert exotic to the Ozarks. It has a serrated blade with a strong left bevel. It resembles a Dalton point in some respects, but it has distinct side notches and lacks basal thinning (Figure 8.16). Found at the base of the middle submember just above the Dalton horizon, it may represent a style transitional between Dalton and later Early Archaic Graham Cave (cf. Graham Cave found 219 cm bs, Figure 8.15g).

Two radiocarbon dates are associated with the upper and lower portions of the Early Archaic deposits at the Big Eddy site (Table 7.1). One small piece of wood charcoal collected from the south wall of TU 3 at a depth of 190–192 cm bs yielded a radiocarbon age of 8190 ± 60 B.P. (AA-29019). An-

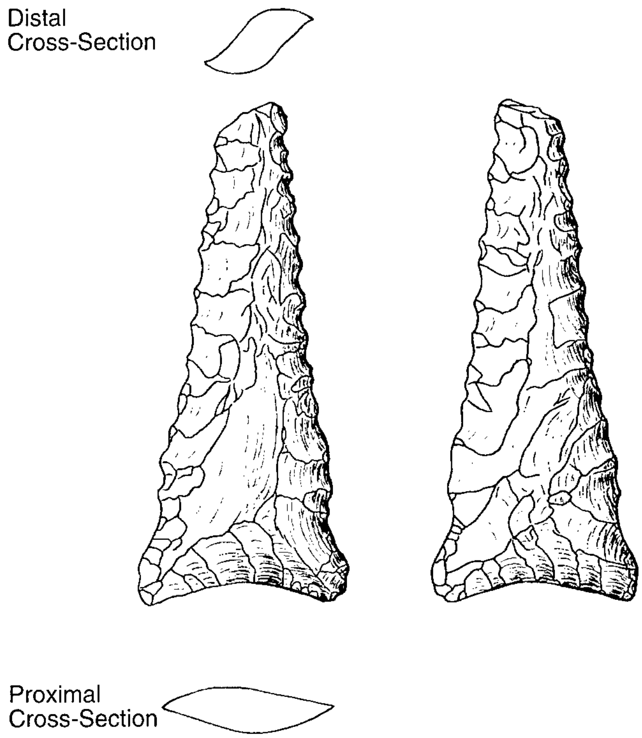


Figure 8.16. Early Graham Cave point, possibly transitional between Graham Cave and Dalton. Note the shallow side notches, lack of basal thinning, and strongly bevelled blade. (Actual size).

other small fragment of wood charcoal recovered from the southwest portion of Block B at a depth of 251 cm gave a date of 9525 ± 65 B.P. (AA-27479). Stratigraphically, this AMS sample was collected approximately 11–17 cm above the early Graham Cave point from Trench 2, which supports the transitional Dalton–Graham Cave interpretation suggested above. A third Early Archaic date came from a natural burn feature in the cutbank at 286 cm bs at the contact between the middle and early submembers (T1c surface and top of 3Ab horizon). It yielded an age of 9190 ± 90 B.P. (Beta-112982). It is unclear whether this feature represents a burned tree stump resting on the 3Ab horizon or a burned root from a much higher elevation. Based on several radiocarbon ages greater than 10,000 B.P. from the 3Ab horizon and the earlier date of 9525 B.P. from 35 cm above, the latter explanation seems more plausible at this time.

At least one other projectile point/knife type appears to be associated with the early Early Archaic deposits at the Big Eddy site. It is a large, lanceolate-shaped point similar to Agate Basin but designated by Wyckoff (1985) as Packard (Figure 8.15a-e). Considerable confusion has arisen in the western Ozarks concerning well-made, unfluted, narrow, lanceolate points designated as Agate Basin or Agate Basin–like (see O'Brien and Wood 1998:86–89). Although some suggest an extension of the Agate Basin manifestation into the Ozarks and even into the Eastern Woodlands (Chapman 1975:241; Justice 1987:34), true Agate Basin points appear to be centered in the western and central Plains (Frison 1978:31). In original (unresharpened) form, they are long lanceolates with slightly excurvate, delicately retouched blades; constricting stems with convex, straight, or concave base; and a very thin "smoothly lenticular" cross-section (Fri-

son and Stanford 1982:81). As pointed out by O'Brien and Wood (1998:87), few specimens from Missouri meet these specifications; however, not all Agate Basin look-a-likes in Missouri should be classified as Rice (Searcy) Lanceolates. Instead, the Packard point type constitutes a distinctly separate lanceolate form found in the western Ozarks and adjacent areas.

Although morphologically similar to Agate Basin and Searcy (Rice) Lanceolate points, there are important technological differences. In comparison to Agate Basin, Packard points are much thicker and usually exhibit a diamond-shaped cross-section (Wyckoff 1985:16). Both exhibit collateral or near-collateral flaking, but Packard point flake scars terminate along the midline, creating a thick medial ridge and the diamond cross-section. Wyckoff (1985:17) also noted that Packard knappers preferred cobble-blank reduction as opposed to Agate Basin flake-blank reduction. Searcy points differ from Packard points in several regards. Primary among these are flaking pattern and resharpening attributes. In contrast to fine parallel-flaked Packard points, Searcy points exhibit a more random flaking pattern. Searcy points also often exhibit a distinct break or shoulder at the haft-blade juncture that is never present on Packard points. Some Searcy points may even exhibit a stemmed appearance due to a broadening blade above the ground haft area (Chapman 1975:253). Resharpened Searcy points are distinct in that they exhibit a moderately to strongly bevelled and often serrated blade, whereas the blade edges of resharpened Packard points are evenly flaked without serrations. Finally, the widest portion of Searcy points is at the midpoint or in the lower half, whereas the widest portion of unresharpened Packard points is along the distal half, approximately two-thirds of the way from the base (resharpened specimens are widest at the midpoint).

Aside from the above technological considerations, there appears to be a distinct temporal difference between Packard points and Searcy and Agate Basin points. Unfortunately, all five of the Packard points recovered from the Big Eddy site were found out of context on cutbank slumpage by local collectors. Nevertheless, several radiometric dates were associated with an isolated assemblage of Packard points from the Packard site in northeast Oklahoma (Wyckoff 1985, 1989). These uncalibrated dates range from 9416 ± 193 to 9880 ± 90 B.P., which correlates with one of the early Early Archaic dates obtained from the lower portion of the middle submember at the Big Eddy site. Extrapolation would place Packard points in the 2Btb4 and 2Btb5 horizons at approximately 240–280 cm bs, or just above the 3Ab (Dalton) horizon (see Figure 7.11) at Big Eddy. This proposed stratification of Dalton and Packard points at Big Eddy, however, reverses the relationship reported by Wyckoff (1985) at the Packard site. This discrepancy makes a careful investigation and documentation of in situ Packard artifacts at the Big Eddy site a primary concern of future investigations. Agate Basin and Searcy Lanceolate points appear to be earlier and later, respectively. For example, Agate Basin points appear to be roughly contemporaneous with Late Paleoindian Dalton points (Frison 1978:31, 1982:Table 2.2), whereas recent cave excavations in central and southwest Missouri date Searcy (Rice) Lanceolate points to late Early Archaic times (Markman 1993:61; Ray 1995b:39, 1997:18, 36).

Summary and Conclusion

Midcontinental and Eastern North America witnessed a tremendous diversification of projectile point/knife forms during the Early Archaic period. Although some lanceolate forms continued into this period, a wide array of corner-notched, side-notched, and stemmed varieties appeared, probably in response to functional and technological changes and adaptations (O'Brien and Wood 1998:109–112). Numerous types of Early Archaic projectile points/knives have been recovered from sites in the lower Sac River valley, including the Montgomery site (Collins et al. 1983) and the Big Eddy site. Unfortunately, only a few of these types have been recovered in situ. Due to the considerable time depth represented by the middle submember and its dispersed charcoal content, future investigations at the Big Eddy site hold great potential for deciphering the ages of several Early Archaic point types.

Only the earliest portion of the Early Archaic period received much attention during the 1997 field season at Big Eddy. Even so, enough data were obtained to establish a general chronological framework and suggest tentative projectile-point associations. Not enough diagnostic points were found in context to discuss individual components, so point types are grouped by time period. The Early Archaic deposits at Big Eddy are divided into early and late subdivisions. The early Early Archaic arti-

facts were recovered from the lower portion of the middle submember. The only diagnostic artifact firmly associated with the early Early Archaic deposits is a transitional Dalton-like Graham Cave point. This early Graham Cave point (Figure 8.15h) exhibits faint (shallow and broad) side notches that do not create a radical stem-blade juncture as on more deeply notched (later) Graham Cave points (Figure 8.15g). This suggests it has a close affinity to or is the immediate successor of Dalton points. An early date (9525 B.P.) stratigraphically above the point supports this association

Although still unconfirmed, it is suspected that at least three other points are associated with the early Early Archaic deposits. Based on data from the Packard site (Wyckoff 1985, 1989) and on Big Eddy radiocarbon dates, Packard Lanceolate points are probably located in the lowermost portion of the middle submember, approximately 250–285 cm bs. Cache River points are also probably associated with the lower middle submember. In addition to the Packard Lanceolate points, Wyckoff (1985:19) found a side-notched point at a depth of 290 cm at the Packard site. Although unidentified as to type, this point is undoubtedly a Cache River based on the characteristic small, narrow side notches placed close to a straight base. Seven Cache River points were recovered from the Montgomery site, one of which was found in situ at a depth of 280 cm (Collins et al. 1983:32, 70). Although not common, Scottsbluff points are also occasionally found in the prairie regions of Missouri (O'Brien and Wood 1998:124). Several have been found in the Sac River valley by private collectors, and at least three specimens were recovered from the Montgomery site (Collins et al. 1983:Figure 15). Since practically every other Early Archaic point type found at Montgomery has also been found at Big Eddy, it is reasonable to expect Scottsbluff points will eventually turn up there as well. Since they appear very early in the Early Archaic period (Frison 1978:105; Hofman 1996:69; O'Brien and Wood 1998:124), it is also expected that they will be found in the lowermost portion of the middle submember.

The late Early Archaic artifacts are associated with the lower-middle portion of the middle submember at approximately 180–230 cm bs. More extensive work needs to be conducted in this zone to tease apart projectile-point associations; until that can be accomplished, they are lumped together here. One classic form of Graham Cave with well-defined side notches (Figure 8.15g) was found in situ (219 cm) during the excavations. This clearly appears to be a successor of the Dalton-like Graham Cave point found approximately 45 cm deeper. Searcy (or Rice) Lanceolate and Hidden Valley (or Rice) Contracting Stem points were found in the cutbank at approximately 210 and 180 cm, respectively. Although there is considerable mixing in the various levels of Rodgers Shelter, it appears that most of the Searcy points were found in slightly lower stratigraphic positions than most Hidden Valley points (Kay 1982e:547; O'Brien and Wood 1998:119, 129). This appears to be supported by recent radiocarbon dates obtained from sheltered sites in southwest Missouri. For example, uncalibrated ages of 7160 ± 180 B.P. and 7540 ± 90 B.P. were associated with a well-defined stratum containing several Searcy points at John Paul Cave (Ray 1997:36), and an uncalibrated date of 7090 ± 90 B.P. was obtained from a burial containing a Hidden Valley fragment at Great Spirit Rockshelter (Ray 1994b:37). It is entirely possible that Hidden Valley is a direct successor to Searcy since in any large sample of the two types there is a clear gradation of lanceolate to stemmed and shouldered forms. Although not yet associated with a specific depth, Hardin (Montgomery) Barbed, Rice Lobed, and Jakie Stemmed points are also probably associated with the late Early Archaic horizon at the Big Eddy site. Uncalibrated radiocarbon dates of 8500 ± 220 B.P., 8410 ± 245 B.P., and 8140 ± 150 B.P. have been associated with these point types, respectively (Dickson 1991:265; O'Brien and Wood 1998:128; Ray 1994b:13).

LATE PALEOINDIAN

Some of the most intensive prehistoric occupations at the Big Eddy site occurred during the Late Paleoindian period. These occupations were sufficiently intensive to organically enrich the now deeply buried living surfaces, i.e., the 3Ab horizon. Late Paleoindian materials are confined to this distinct stratum (see Figure 4.5) at the top of the early submember at a depth of 285-320 cm bs that is modified by the 3Ab horizon of Buried Soil 1 (Figure 7.14) (note: when the phrase "3Ab horizon" is used in this chapter, it refers to this youngest stratum). In Blocks B-D, the top of the 3Ab horizon begins at about 285 cm bs, or the middle portion of Level 29. Because this level likely contains material from both Late Paleoindian and early Early Archaic components and because it is an interface zone or hori-

zon boundary where mixing is likely to occur, debitage that was recovered from Level 29 (280–290 cm) was not included in the lithic analyses. Figures 8.17–8.19 depict the profile of the 3Ab horizon along the east wall of Block B, the south wall of Blocks B and C, and the west wall of Block C, respectively. In the following lithic analyses, the 3Ab horizon has been divided into three 11–12-cm-thick subsections: upper (285–297 cm bs), middle (297–308 cm bs), and lower (308–320 cm bs).

Hand excavations in Blocks B-D began just above the 3Ab horizon and continued well into underlying 3Bt horizons. Within the 3Ab horizon, a total of 23 test units (approximately 70 m^2, 16.1 m^3) was excavated in conjoined Blocks B and C (Figure 8.20). Seven additional test units (14 m^2, 2.7 m^3) were dug within the 3Ab horizon in Block D (Figure 8.21) located approximately 25 m north of Block B. Debitage from test units located on the steeply dipping T1c stream bank (i.e., debitage collected from TU 23, 24, 28, 29, and 31) has been excluded from the lithic analyses. Piece-plotted tools from these test units and Level 29, however, are assigned to the Late Paleoindian component and are included in the analyses.

Because the vast majority of the artifacts recovered during the 1997 investigations are nondiagnostic or indeterminate as to specific component, most of the data will be discussed together as undifferentiated Late Paleoindian. Nevertheless, short subsections on Dalton and San Patrice diagnostic artifacts will describe tools distinctive to each component. A third subsection will discuss other artifacts believed to be associated with one component or the other.

Chipped-Stone Debitage

The vast majority of artifacts (98.4%) from the Late Paleoindian horizon consists of debitage. A plot of debitage density by depth reveals that the bulk of the debitage is concentrated in Levels 30 (290–300 cm bs) and 31 (300–310 cm bs), or the upper and middle portions of the 3Ab horizon (Figures 8.22–8.24). A significant decrease occurs in Level 32 (310–320 cm), the lower 3Ab horizon. These trends are apparent in Blocks B-C and in Block D. In the five test units located on the T1c stream bank on the west side of Block C, where the 3Ab horizon is 25–30 cm or more lower, the peak in debitage density occurs in Level 33 (320–330 cm), as would be expected. It is interesting that limited test excavations at the Montgomery site revealed peak densities of Late Paleoindian debitage at about the same depths (300-330 cm bs) as that found at Big Eddy (Collins et al. 1983:26-28; Donohue et al. 1977:125-128).

The debitage is divided into core and flake debitage. Only 11 pieces of core debitage were recovered from the Late Paleoindian component, and all but three of these are tested cobbles that were subsequently rejected. A general lack of formal flake-blank cores indicates that Late Paleoindian knappers employed a cobble-blank technology with little or no use of a flake blanks. In other words, flakes utilized as and/or modified into tools were more likely selected from cobble-blank waste debris than produced from formal flake-blank cores. Over 10,000 pieces of flake debitage were collected from the 3Ab horizon in Blocks B-D (Table 8.1). The bulk of this debitage consists of flake fragments, followed closely by biface flakes. Primary and secondary (decortication) flakes represent approximately 3% and 7% of the assemblage respectively. Tertiary (interior) flakes are relatively rare, totaling only slightly more than primary flakes. The scarcity of tertiary flakes is also indicative of a cobble-blank technology as opposed to a flake-blank technology. As a result, it appears that nearly all of the flake debitage represents by-products of intensive manufacture of bifacial chipped-stone tools, especially hafted bifaces.

As noted in Chapter 6, the majority of the excavations in Blocks B-D were conducted via careful shovel skimming with a sample portion screened through 0.25-in mesh. Table 8.5 compares artifact data from Test Unit 4 (Levels 30–32), one quadrant of which was screened and the other three quadrants of which were shovel skimmed. Although screening resulted in the recovery of three times the material recovered by shovel skimming, there are no major differences in the percentages of chert types or artifact types in the screened and unscreened samples. As might be expected, a slightly higher percentage of (larger) secondary flakes is represented in the unscreened sample and a slightly higher percentage of (smaller) flake fragments is represented in the screened sample.

Chipped-Stone Nondiagnostic Tools

Chipped-stone tools are divided into informal and formal categories. Informal tools consist of flakes that exhibit edge modification due to use

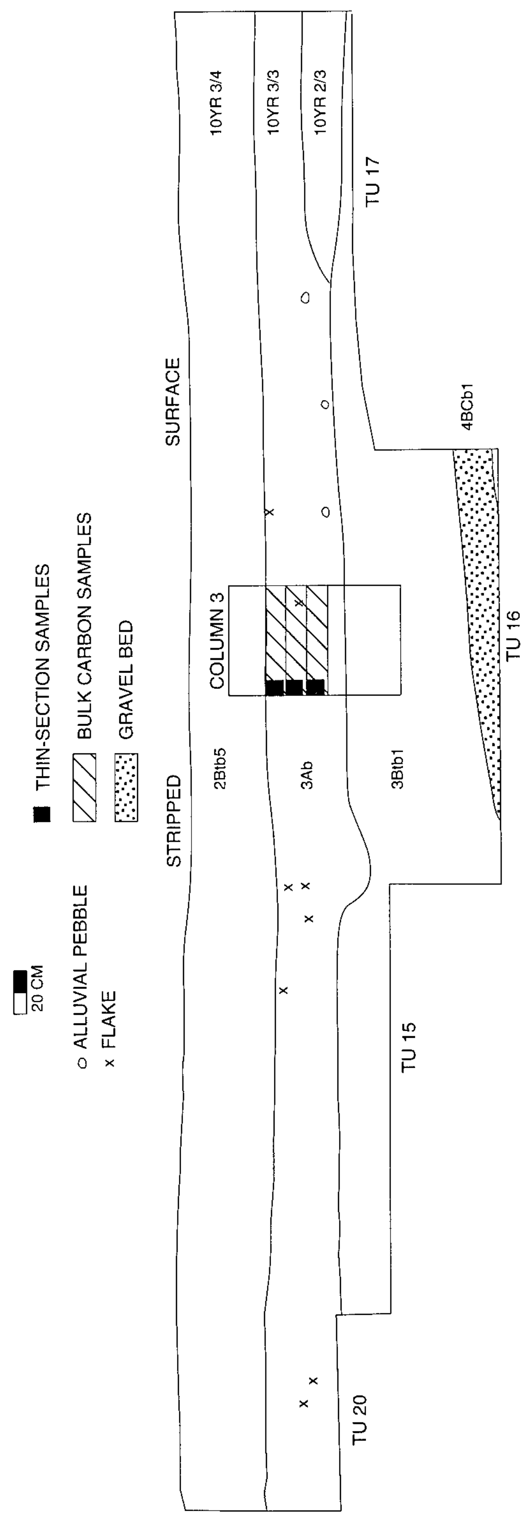


Figure 8.17. East wall profile of 3Ab in Block B.

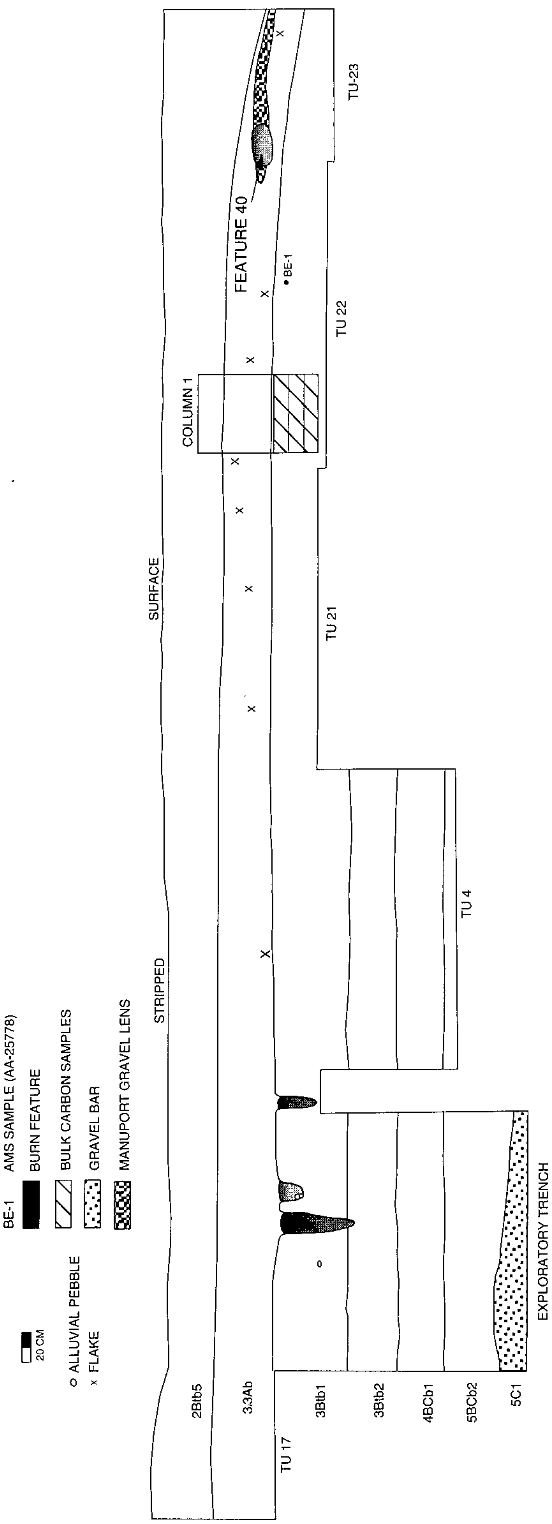


Figure 8.18. South wall profile of 3Ab, Blocks B and C.

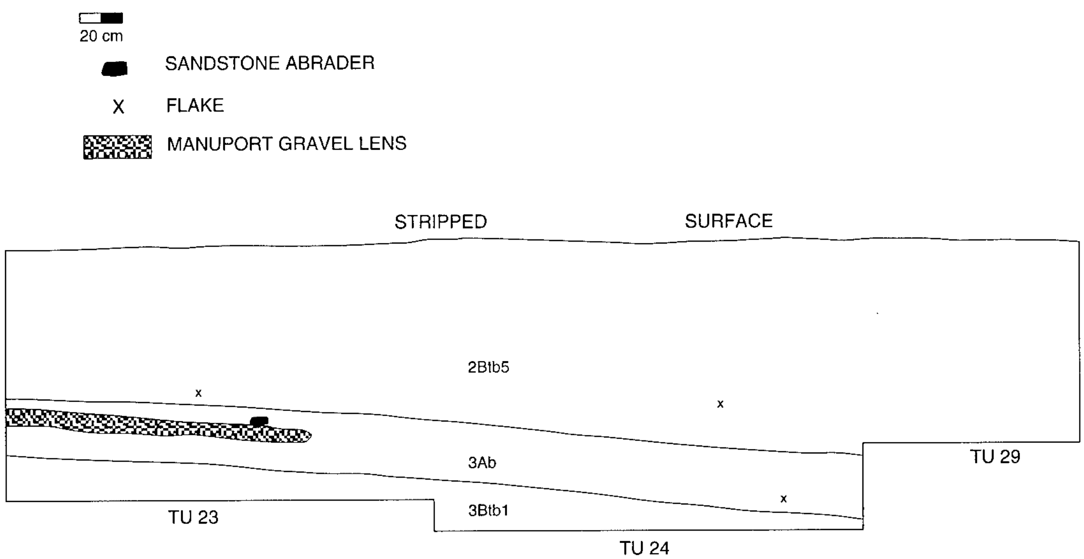


Figure 8.19. West wall profile of 3Ab, Block C.

(utilized flakes) and flakes that exhibit polished surfaces (polished flakes). For the Late Paleoindian component, tools have also been divided into two collection samples. First, tools from all contexts (i.e., block excavations and cutbank deposits) are presented in Table 8.6. Second, Late Paleoindian tools that were recovered only from controlled block excavations are presented by level in Table 8.7. The following discussion focuses on those artifacts recovered only from excavation contexts (Levels 30–32 in Blocks B-D).

A total of only 28 flakes exhibit utilized edges, which is less than one utilized flake per test unit excavated in the 3Ab horizon. This low percentage of utilized flakes appears to reflect the primary activity conducted in the vicinity of Blocks B-D, i.e., the production of bifacial tools. The utilized flakes are irregular in shape and do not indicate a formal production of blade or flake tools (Figure 8.25a). Most utilized flakes appear to have been collected from waste debitage and used for expedient purposes. Use wear may occur on one or two sides and/or ends of the waste flake. Some of the utilized flakes exhibit irregular edge nibbling or modification and this may actually be accidental or unintentional, a result of walking on a pavement of debitage strewn across the workshop floor.

Two utilized flakes were associated with Feature 28, the largest of 16 concentrations of knapping debris defined in the Late Paleoindian horizon. The other flakes were found on the workshop floor between knapping piles. At least some of the utilized flakes from the 3Ab horizon, however, are probably utilitarian tools used for cutting, slicing, and scraping. A few exhibit cortex opposite the working edge and may represent backed knives. Similar utilized flakes (knives) are represented in cached Dalton tool kits (Morse 1971:17–19; Walthall and Holley 1997:156).

Two types of polished flakes were recognized: (1) flakes that exhibit high polish on dorsal surfaces and (2) flakes that exhibit smaller and more localized irregular areas of polish on dorsal or ventral surfaces. Polish of the first type appears to represent woodworking use wear. These polished flakes are a result of resharpening or rejuvenating the bit end of heavily utilized chipped-stone adzes. The origin of the other type of polished flake is unknown. The polish usually consists of small irregular streaks or blotches, often on the ventral side. Based on the unusual position of the localized polish areas on some flakes (e.g., central portion of ventral surface), it is suspected that this type of polish may be noncultural in origin.

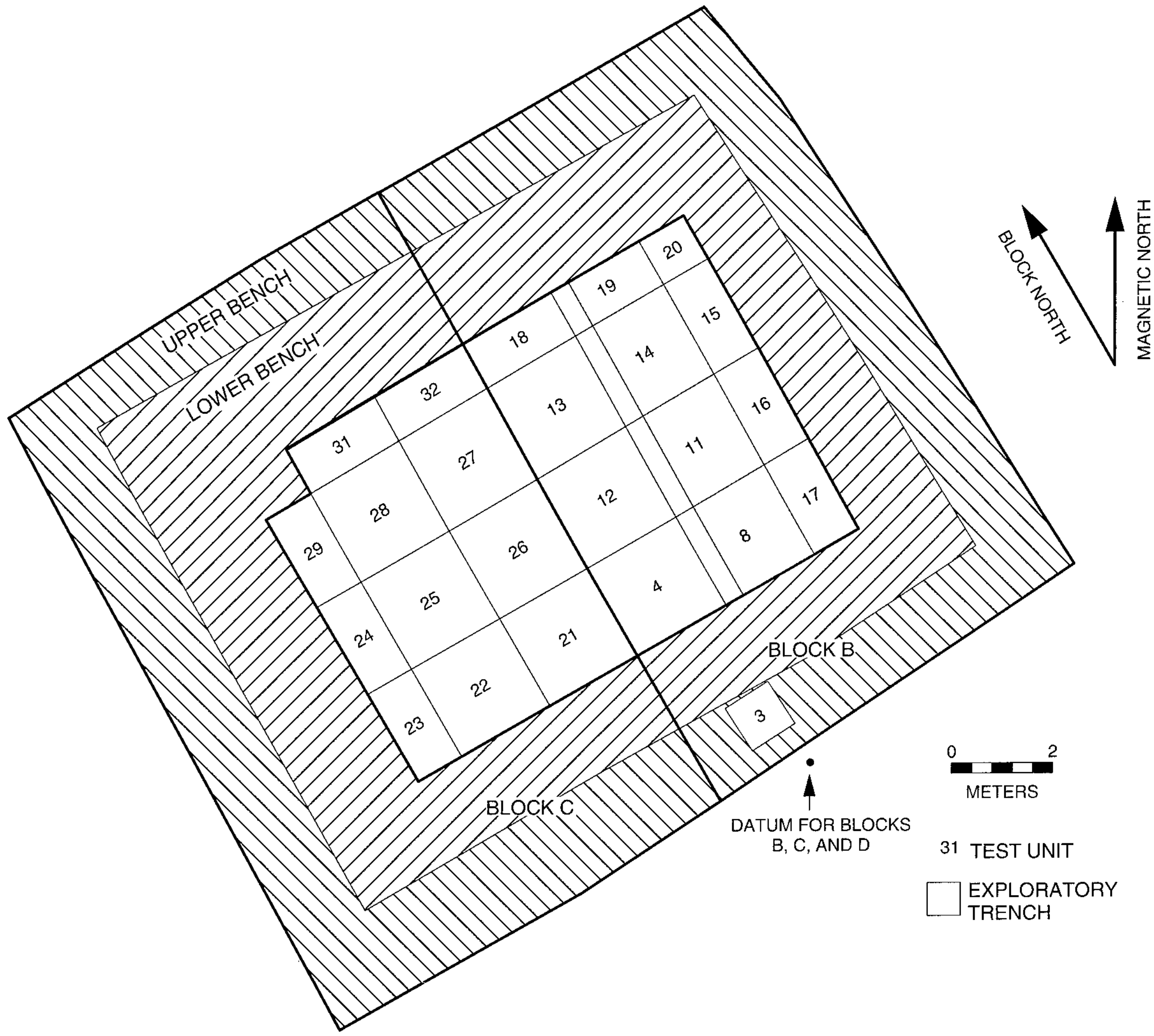


Figure 8.20. Plan view of excavation units in Blocks B and C.

Formal tools are manufactured for a specific task or tasks, have a generalized morphology, and are produced by primary, secondary, and/or tertiary flaking. It should be noted, however, that the formal tool category includes unfinished tools as well as finished and utilized tools. Indeed, approximately three-quarters of the formal tools recovered from the site represent production failures or preforms (i.e., primary bifaces and secondary bifaces) that were broken or otherwise rejected during tool manufacturing. The distribution of finished tools (e.g., projectile points/knives, scrapers, drills, and tertiary bifaces) in Blocks B-C is presented in Figure 8.26. Nondiagnostic tools are described first below, followed by Late Paleoindian projectile points/knives diagnostic to either San Patrice or Dalton, and a few other tools suggested as potentially diagnostic to either Late Paleoindian component.

Late Paleoindian unifacial tools are made up of scrapers and gravers. A total of 19 scrapers was recovered. These consist of 11 end scrapers, five side scrapers, and three scraper fragments indeterminate as to orientation of the scraping edge. End scrapers vary significantly in size and shape. Many appear to have been shaped from fortuitously recurved flakes selected from workshop debitage. These may represent expedient scrapers, most of which were minimally retouched. Examination of platforms revealed that at least three were made from biface (thinning) flakes, two of which exhibit

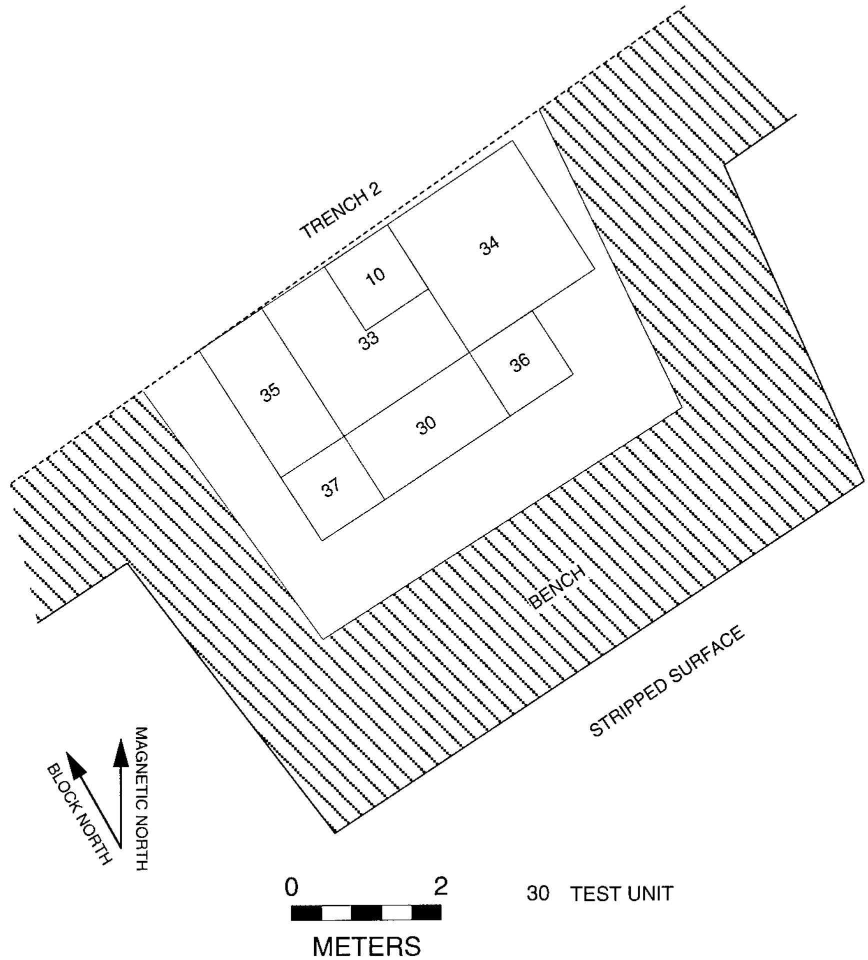


Figure 8.21. Plan view of excavation units in Block D.

broad, fan-shaped distal (working) ends over 5 cm in width (Figure 8.25i). Other end scrapers appear more formalized in shape, probably intentionally knapped from prepared tabular cores. Initial-stage (unresharpened) scrapers of this type exhibit a triangular form with an elongated stem (Figure 8.25k-l). Extensively resharpened or exhausted forms, on the other hand, are much shorter with only the socketed/hafted proximal end remaining (Figure 8.25e-f). Invariably, the bulb of percussion was used as the proximal or hafted end, whereas the distal recurved portion of the flake blank was utilized as the scraping end. Occasionally, the bulb of percussion was thinned by pressure flaking to facilitate hafting.

All but one of the end scrapers from Blocks B-D were recovered from Levels 30 and 31. Four end scrapers exhibit spur-like irregularities on one corner of the bevelled bit. Three of these may be unintentional or fortuitous, a result of extensive bit resharpening; however, at least one end scraper exhibits a prominent spur that was produced intentionally (Figure 8.25h). Spurred end scrapers have long been recognized as part of the Late Paleoindian tool kit with spurs located on the left (Biggs et al. 1970:41; Webb et al. 1971:20–21) or right (Goodyear 1974:45) sides. These specialized scrapers appear to have doubled as piercing, etching, or engraving tools. One specialized function may have been to delicately etch the eyelets on bone needles (Morse and Morse 1983:78).

Side scrapers (Figure 8.25d) exhibit a less formalized shape and appear to be more expedient in nature. It is unclear if they were hafted. All of the

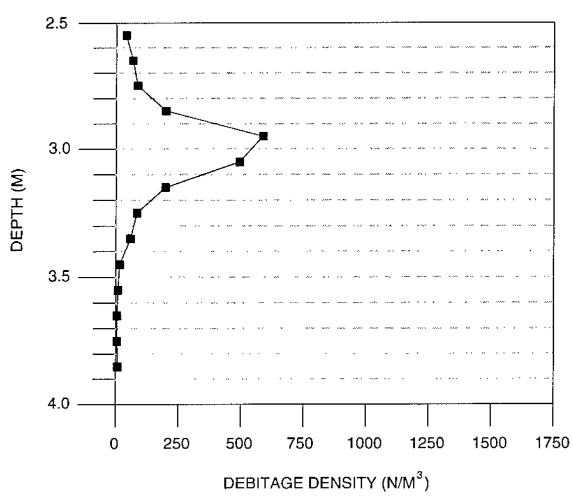


Figure 8.22. Late Paleoindian debitage density in Blocks B and C test units east of T1c stream bank

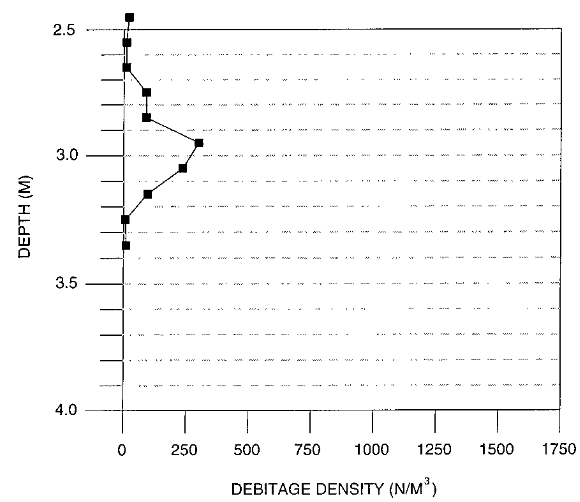


Figure 8.23. Late Paleoindian debitage density in Block D.

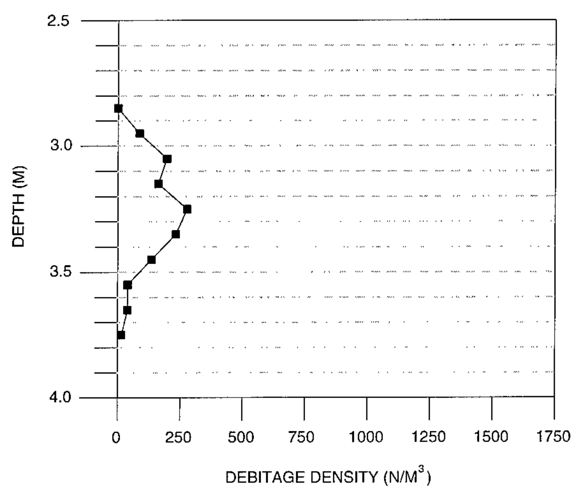


Figure 8.24. Late Paleoindian debitage density in Block C test units on dipping strata west of T1c stream bank.

Table 8.5. Artifact Data from Screened and Unscreened Samples of the Late Paleoindian Component in TU 4.

	Screened		Unscreened		Total	
Artifact Data	N	%	N	%	N	%
Raw material						
Jefferson City chert	361	89.6	346	88.0	707	88.8
Burlington chert	22	5.5	31	7.9	53	6.7
Chouteau chert	20	5.0	16	4.1	36	4.5
Total	403	100.0	393	100.0	796	100.0
Artifact type						
Primary flake	9	2.2	10	2.5	19	2.4
Secondary flake	12	3.0	21	5.3	33	4.1
Tertiary flake	15	3.7	18	4.6	33	4.1
Biface flake	100	24.8	93	23.7	193	24.2
Flake fragment	261	64.8	242	61.6	503	63.2
Primary biface	1	0.2	1	0.3	2	0.3
Secondary biface	1	0.2	2	0.5	3	0.4
Graver	1	0.2			1	0.1
Side scraper			1	0.3	1	0.1
Utilized flake	3	0.7	5	1.3	8	1.0
Total	403	100.0	393	100.0	796	100.0

side scrapers and unspecified (broken) scrapers were found in Levels 30 and 31. Only two Late Paleoindian flake gravers were found, both in Level 30. One consists of a large flake on which a natural sharp projection was minimally retouched (Figure 8.25b), whereas the other is a small flake that was intentionally flaked into a "beaked" or pointed end (Figure 8.25c). Neither flake graver appears to have been hafted.

Tertiary bifaces represent fragments of finished bifacial tools such as unidentifiable midsections and distal ends of projectile points/knives or very late-stage preforms. Only six Late Paleoindian tertiary-biface fragments were found in the 3Ab horizon. Two of these are refit fragments: a midsection and a distal end that probably represent the blade portion of a broken Dalton projectile point/knife (Figure 8.27b). This probable Dalton blade fragment, which exhibits a left bevel, appears to have broken during use. A third basal fragment may represent a late-stage Dalton preform. It is a corner-tang fragment with one straight to slightly convex side and a concave base with channel (flute?) scars on both faces that are truncated by longitudinal and diagonal breaks (Figure 8.27a). Lateral and basal grinding are absent, indicating that this artifact probably represents a late-stage production failure. A fourth small tertiary-biface fragment is possibly a failed late-stage San Patrice preform. It is very thin (0.50 cm) and appears to represent one corner of a nearly finished preform. A fifth fragment appears to have been intentionally broken or "killed," and the last tertiary biface is a small, indeterminate lateral-edge fragment.

Other finished bifacial tools represented at the site include one drill and two chipped-stone adzes. The drill was broken during use; it exhibits an unusual, wide, bulbous-shaped base (Figure 8.25o). Two refit fragments (base and midsection) of the drill were found approximately 2.5 m apart at 297 cm and 302 cm bs (middle 3Ab), respectively. The adzes (Figure 8.25m-n) are complete specimens that were found on cutbank slumpage, one by the author and the other by a private collector. They are very similar in most respects. Both are short (6.92 and 6.93 cm long) and appear to be expended or exhausted forms. They are relatively small compared to adzes found at the Montgomery site (Collins et

Table 8.6. Late Paleoindian Tools by Provenience.

Artifact Type	Cutbank N	Cutbank %	Excavation Units and Features N	Excavation Units and Features %	Total N	Total %
San Patrice point			3	2.0	3	1.8
Wilson point			1	0.7	1	0.6
Dalton point	3	20.0			3	1.8
Utilized flake			30	19.6	30	17.9
Adze polished flake			5	3.3	5	3.0
Other polished flake			6	3.9	6	3.6
Adze	1	6.7			1	0.6
Primary biface	1	6.7	30	19.6	31	18.5
Secondary biface	7	46.7	53	34.6	60	35.7
Tertiary biface			6	3.9	6	3.6
Drill			1	0.7	1	0.6
End scraper	3	20.0	8	5.2	11	6.5
Graver			2	1.3	2	1.2
Side scraper			5	3.3	5	3.0
Unspecified scraper			3	2.0	3	1.8
Total	15	100.0	153	100.0	168	100.0

Table 8.7. Late Paleoindian Tools by Level.

Tool Type	Level 30 N	Level 30 %	Level 31 N	Level 31 %	Level 32 N	Level 32 %	Level 33A[a] N	Level 33A[a] %	Total N	Total %
Utilized flake	14	46.7	15	50.0	1	3.3			30	100.0
Adze polished flaked	1	20.0	4	80.0					5	100.0
Other polished flake	4	66.7	1	16.7	1	16.7			6	100.0
San Patrice point	3	100.0							3	100.0
Wilson point							1	100.0	1	100.0
Primary biface	16	53.3	13	43.3	1	3.3			30	100.0
Secondary biface	29	54.7	17	32.1	7	13.2			53	100.0
Tertiary biface	1	16.7	3	50.0	2	33.3			6	100.0
Drill	1	100.0							1	100.0
End scraper	2	25.0	5	62.5	1	12.5			8	100.0
Graver	2	100.0							2	100.0
Side scraper	2	40.0	3	60.0					5	100.0
Unspecified scraper	1	33.3	2	66.7					3	100.0
Total	76	49.7	63	41.2	13	8.5	1	0.8	153	100.0

[a] T1c stream bank.

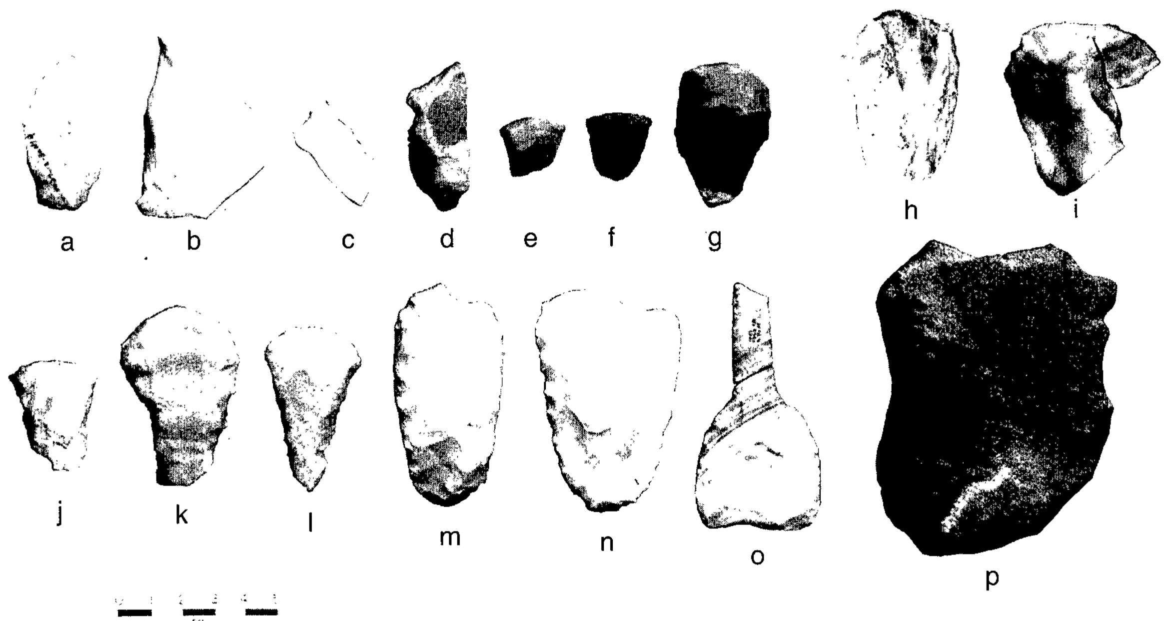


Figure 8.25. Late Paleoindian tools: (a) utilized flake; (b-c) gravers, (d) side scraper; (e-l) end scrapers; (m-n) adzes; (o) drill; (p) grooved abrader.

al. 1983:Figure 19h-k), but they compare favorably in size with adzes found at Rodgers Shelter (Figure 8.28g), the Brand site (Goodyear 1974:39–41), and the Hawkins cache site (Morse 1971:16). Both adzes from the Big Eddy site are well made with cortical surfaces entirely removed from both faces. Unlike specimens from the Brand site, they exhibit only light grinding along the lateral edges and the poll end. The Big Eddy adzes exhibit highly polished ventral surfaces and only limited polish around the edge of the bit on the dorsal surface. Much of the polish, however, was removed by resharpening or rejuvenation of the bit end. Resharpening flakes were removed primarily from the dorsal side of the bit with flake scars oriented toward the poll end. Interestingly, the bit ends of both adzes exhibit concave areas on the right corners. One is a result of use wear and the other has been modified by resharpening. It is unknown whether the similarity is fortuitous or the result of a common, possibly specialized, activity. Morse (1997:31) noted three bifaces (probably adzes) with similar modified corners in the Sloan collection.

Unfinished bifacial tools (i.e., production failures) consist of primary bifaces and secondary bifaces. Comparative metric data are presented in Table 8.8. The distribution of all production failures in Blocks B-C is presented in Figure 8.29, and the distribution of production failures in Block D is presented in Figure 8.30. Primary bifaces are large, thick, irregularly shaped bifacial forms that usually represent raw material that was aborted early in the manufacturing process due to premature breakage, impurities, or other factors. Primary bifaces often retain some cortex. Typical examples of aborted primary bifaces are illustrated in Figure 8.31c-e. Primary bifaces comprise one-quarter of all Late Paleoindian formal tools from the site. Half of the primary bifaces from excavated contexts were found in Level 30 and half were recovered from Level 31. Approximately 60% of the primary bifaces are fragmentary or broken (Table 8.9). All but one small edge fragment appear to have broken as the result of some type of failure associated with biface manufacture. At least two-thirds of these failures appear to be a result of knapper error due to lateral shock, end shock, or overshot fractures. Two (11.1%) of the remaining broken primary bifaces appear to have fractured as a result of raw-material flaws (i.e., incipient fracture planes), and 22.3% are indeterminate as to cause of fracture.

Secondary bifaces are relatively thin, lenticular bifaces that exhibit more systematic secondary flaking and little if any relict cortex. They represent

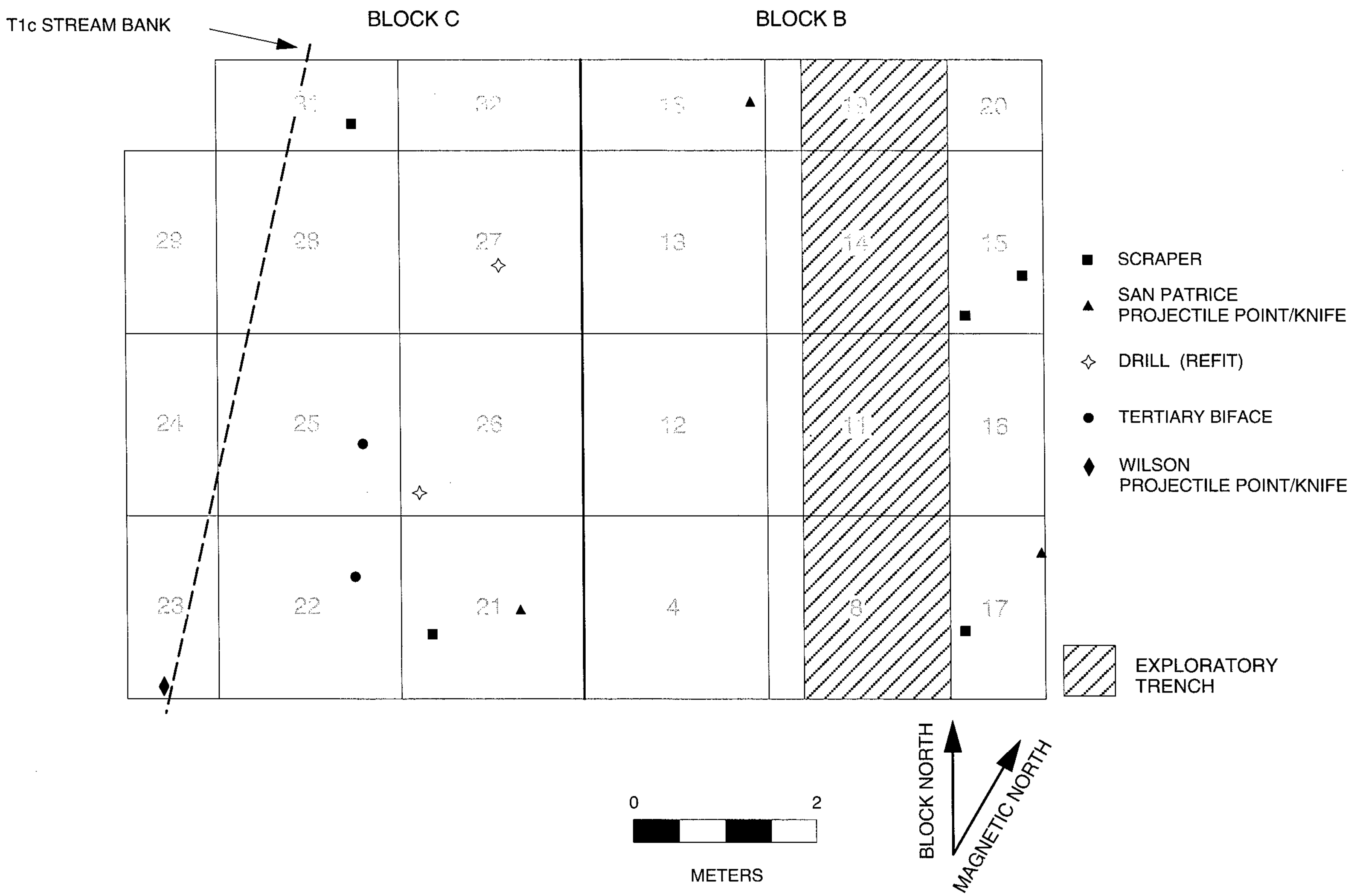


Figure 8.26. Distribution of piece-plotted Late Paleoindian finished tools in Blocks B and C.

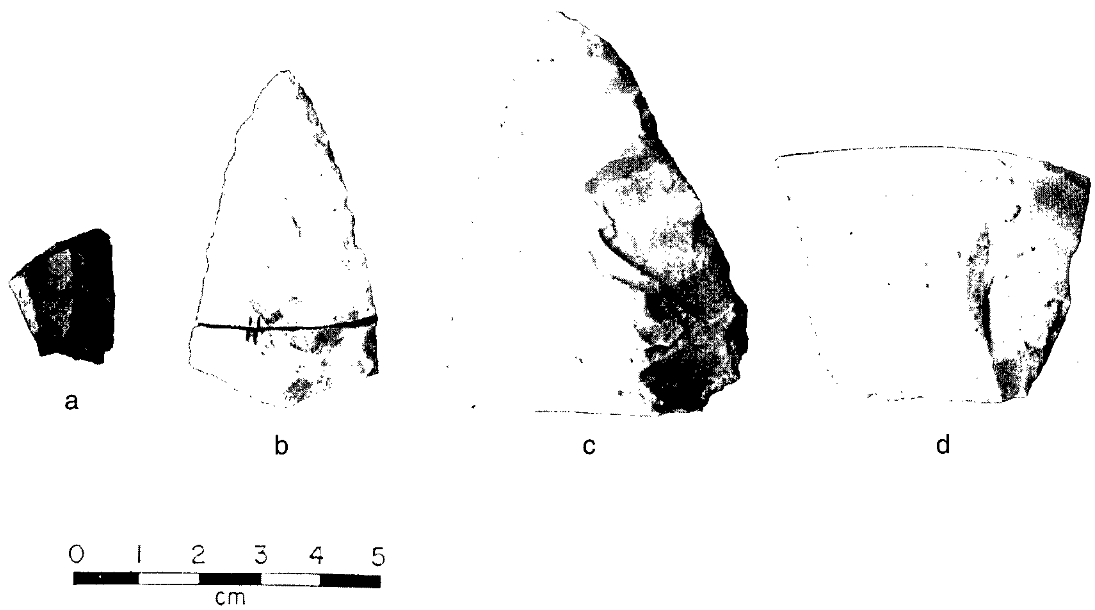


Figure 8.27. Selected Late Paleoindian tool fragments: (a-b) tertiary biface fragments; (c-d) secondary biface fragments.

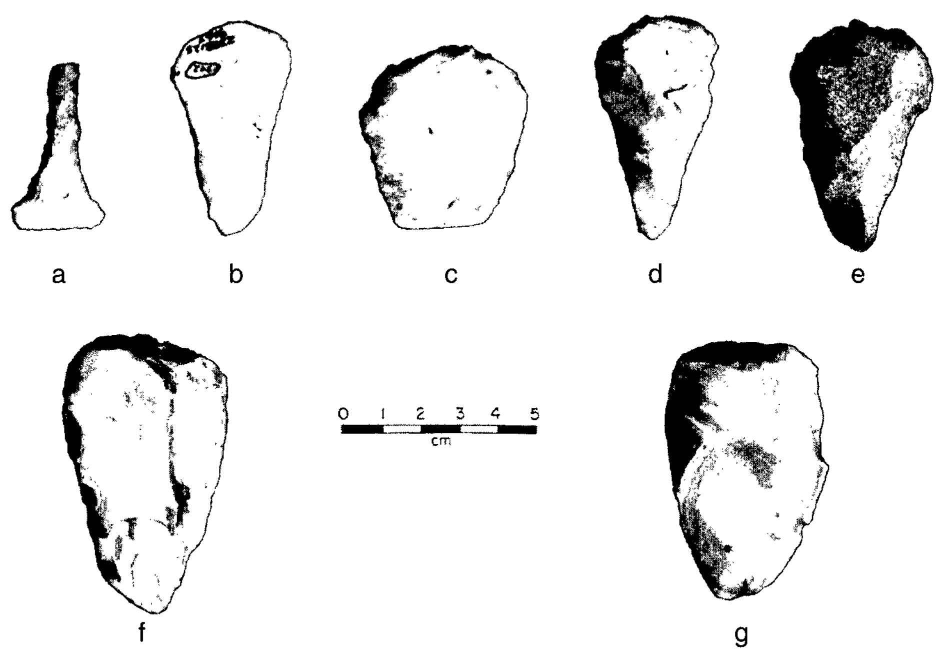


Figure 8.28. Dalton tools from Rodgers Shelter: (a) drill; (b-f) end scrapers; (g) adze (photographed by author from Illinois State Museum collection).

Table 8.8. Late Paleoindian Biface Metric Data.

Statistic	Primary Biface	Secondary Biface	Tertiary Biface	Dalton Point	San Patrice Point	Wilson Point
Length						
N	14	7			2	1
Mean (cm)	8.67	7.70			3.66	
Minimum (cm)	5.46	6.16			3.63	
Maximum (cm)	13.68	9.66			3.68	5.38
Width						
N	20	25	1	3	3	1
Mean (cm)	6.27	4.64	3.15	2.62	2.31	
Minimum (cm)	4.00	2.97	3.15	2.30	1.94	
Maximum (cm)	10.24	8.15	3.15	2.89	2.70	2.47
Thickness						
N	26	33	4	3	3	1
Mean (cm)	2.91	1.09	0.61	0.60	0.46	
Minimum (cm)	1.74	0.63	0.49	0.53	0.38	
Maximum (cm)	4.93	1.88	0.72	0.71	0.51	0.78
Weight						
N	13	6			2	1
Mean (g)	188.51	41.13			4.00	
Minimum (g)	39.98	27.09			3.81	
Maximum (g)	564.10	60.79			4.19	10.47

late-stage reduction failures, mostly broken as a result of overloaded tensile shock as opposed to flaws in the raw material (specimens with such flaws were usually selected out in the primary reduction stage). Secondary bifaces differ from primary bifaces in all attribute measurements (Table 8.8); however, the principal differences are thickness and weight. For example, the mean thickness of secondary bifaces from the Big Eddy site is nearly one-third and mean weight less than one-fourth that of primary bifaces. Representative examples of secondary bifaces are illustrated in Figure 8.32. Secondary bifaces were by far the most common tool type, comprising nearly one-half of all formal tools recovered from the Big Eddy site. Although distributed throughout the 3Ab horizon, over half of those found in excavated contexts were recovered from Level 30 (upper portion of the 3Ab horizon). Over 90% of the secondary bifaces found at Big Eddy were broken, and most of these are production failures (Table 8.9). The most common forms of failure are lateral shock and end shock as exemplified by transverse, longitudinal, and diagonal breaks (Figure 8.32a-e, i). At least three secondary bifaces were broken by end-overshot and side-overshot fractures (Figure 8.32f-h), and 13 exhibit multiple fractures of indeterminate causes (Table 8.9).

Biface-Reduction Strategy

The manufacture of Late Paleoindian bifaces was centered on the reduction of ellipsoidal-shaped stream cobbles. Specifically, Ellipsoidal Jefferson City chert, which occurs in thin lenticular nodules (natural preforms), was the preferred raw material (see Chapter 9). Bifaces were knapped primarily from cobble blanks as opposed to flake blanks in both the Dalton and San Patrice components; i.e., the center or core of cobbles was worked into a tool form rather than a large flake blank detached from

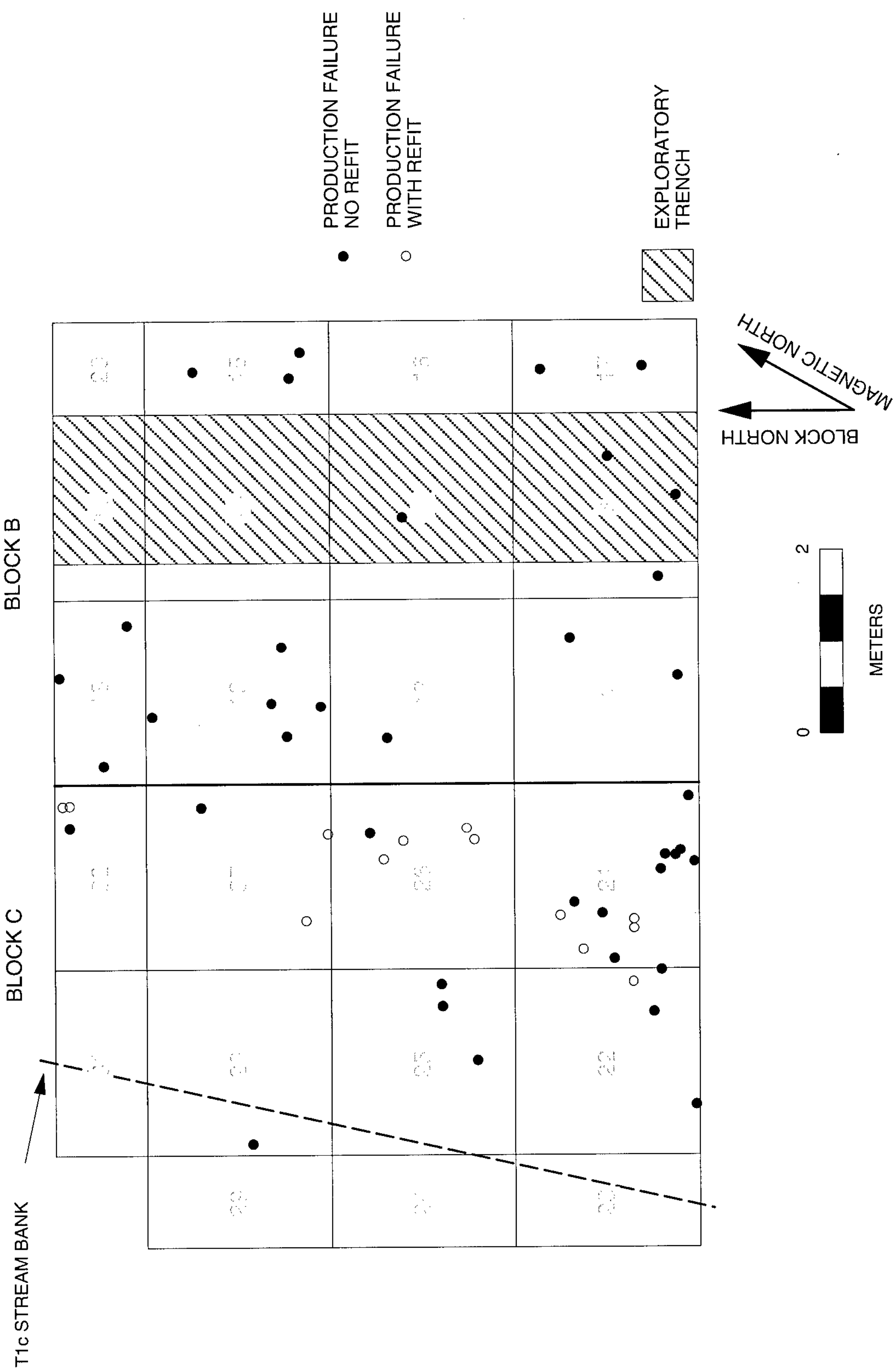


Figure 8.29. Distribution of piece-plotted Late Paleoindian production failures in Blocks B and C. The relative lack of items in TUs 11, 14, and 19 is at least partly due to the incomplete excavation of the 3Ab horizon (Levels 30 and 31 only) prior to excavation of an exploratory trench in these units.

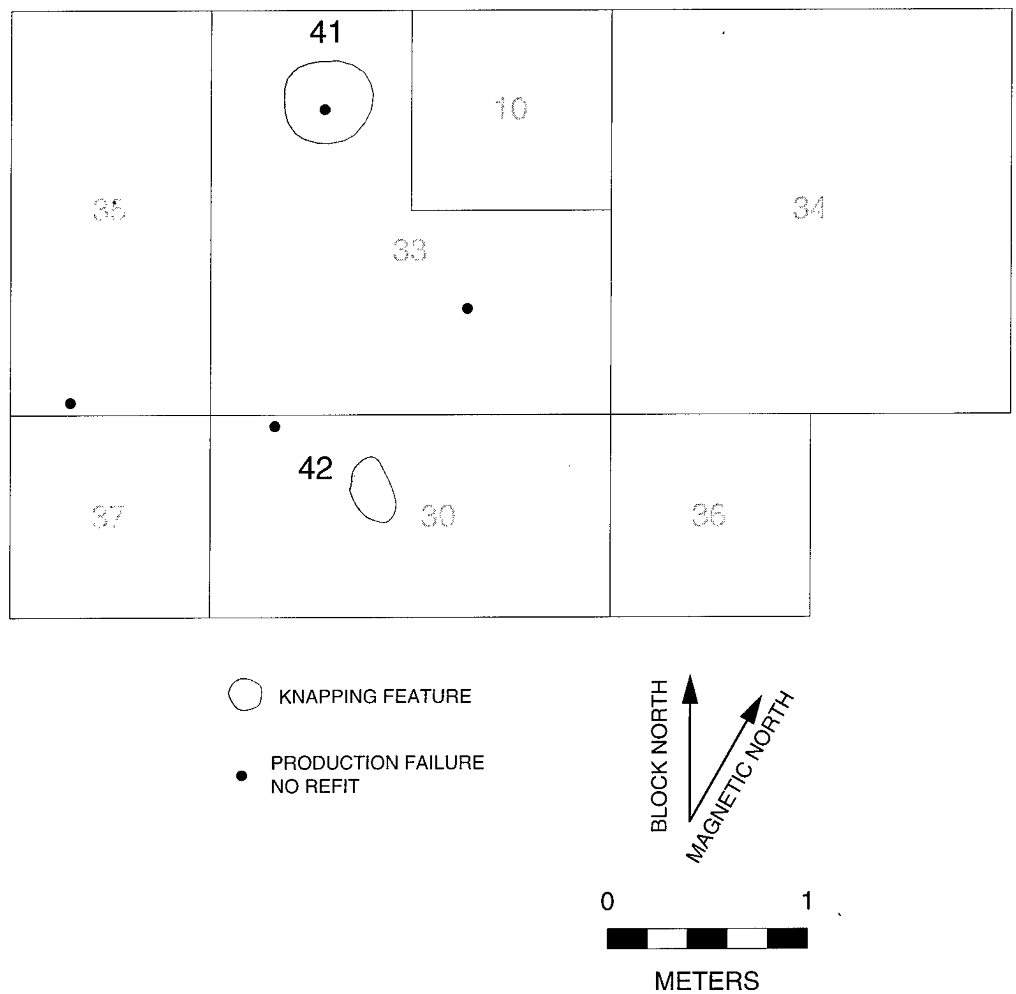


Figure 8.30. Distribution of piece-plotted Late Paleoindian production (preform) failures and knapping features in Block D.

a core. Cobble-blank reduction produces much more debitage (especially decortication flakes and biface flakes) than more formalized flake-blank reduction. Direct evidence of cobble-blank technology was found on at least 12 primary and secondary cobbles that exhibited relict stream cortex on two sides.

Figures 8.31 and 8.33 illustrate the reduction stages of ellipsoidal cobbles from raw-material blanks and tested cobbles, to primary and secondary biface rejections/failures, to finished hafted bifaces. Several Banded Jefferson City chert cobbles and at least one Chouteau chert cobble were also reduced by the cobble-blank method. Late Paleoindian knappers, however, may have taken a different approach to the reduction of Burlington chert. Burlington chert, on average, occurs in much larger and more blocky forms than Jefferson City chert and Chouteau chert (see Chapter 9). Very few aborted preforms of Burlington chert were recovered from the Late Paleoindian levels; however, at least one large Burlington primary biface (Figure 8.31f) appears to be the product of flake-blank reduction. It exhibits alluvial cortex on the dorsal surface and a partially worked bulb of percussion as well as an undulating conchoidal fracture on the ventral surface. Although more primary and secondary bifaces knapped from Burlington chert need to be recovered, it is possible that Late Paleoindian knappers adapted their reduction strategy

Figure 8.31. Late Paleoindian initial biface reduction: (a) cobble blank (unmodified raw material); (b) tested cobble; (c-e) primary bifaces (initial cobble decortication and rejection); (f) primary biface (flake-blank reduction).

to the size and shape of the raw material being worked.

Chipped-Stone Diagnostic Tools

Several Late Paleoindian artifacts have been recovered from the cutbank at the Big Eddy site by private collectors. These include one Dalton point made from Burlington chert in the Charles Collins collection (Figure 8.34a), one Dalton point knapped from nonlocal Lower Reeds Spring chert in the Dan Long collection (Figure 8.34b), and one Dalton point in the Terry Collins collection (Figure 8.34c). The latter point is a Dalton variant (Breckenridge) with a moderately bevelled blade and a flaring stem with long, prominent flutes on both faces (obverse flute: 1 cm wide x 2.5 cm long; reverse flute: 0.5 cm wide x 2.0 cm long). A similar fluted Dalton variant was recovered from the Walters site (Biggs et al. 1970:Figure 8c).

At least two Late Paleoindian components have been identified in the 3Ab horizon: San Patrice and Dalton. It is still unclear, however, if San Patrice and Dalton are stratified within the 3Ab horizon due to the small sample size of recovered diagnostic artifacts. Both point types were found in the middle and upper portions of the buried 3Ab, which suggests at least some contemporaneity. One Dalton point was also found in the lower portion of the 3Ab horizon, and therefore, the Dalton component extends to the base of the 3Ab horizon. Dalton is a resident Late Paleoindian manifestation in the Ozarks (Chapman 1975; O'Brien and Wood 1998), whereas San Patrice appears to be a nonlocal manifestation.

San Patrice

The San Patrice point type in all its variations was originally presented by Duffield (1963). These include the classic variety of San Patrice called Hope as well as the St. Johns variant. A third type, Goodwin, appears simply to be a large form of the Hope variety. San Patrice points are not common in Missouri; they are generally found in the Gulf Coast and southeastern Plains areas (Collins 1995;

Table 8.9. Late Paleoindian Fracture Types.

	Primary Biface		Secondary Biface		Tertiary Biface		Drill		Dalton Point		San Patrice Point		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Whole bifaces	12	40.0	5	9.3							2	66.7	20	20.6
Broken bifaces	18	60.0	49	90.7	5	100.0	1	100.0	3	100.0	1	33.3	77	79.4
Total bifaces	30	100.0	54	100.0	5	100.0	1	100.0	3	100.0	3	100.0	97	100.0
Break type														
Artificial (shovel)			1	2.0									1	1.3
Burinated									1	33.3			1	1.3
Diagonal	2	11.1	7	14.3			1	100.0					10	13.0
End overshot			1	2.0									1	1.3
Impact											1	100.0	1	1.3
Indeterminate	1	5.6											1	1.3
Incipient fracture	2	11.1											2	2.6
Longitudinal	1	5.6	9	18.4									10	13.0
Multiple	3	16.7	14	28.6	4	80.0							21	27.3
Side overshot	3	16.7	2	4.1									5	6.5
Transverse	6	33.3	15	30.6	1	20.0			2	66.7			24	31.2
Total	18	100.0	49	100.0	5	100.0	1	100.0	3	100.0	1	100.0	77	100.0

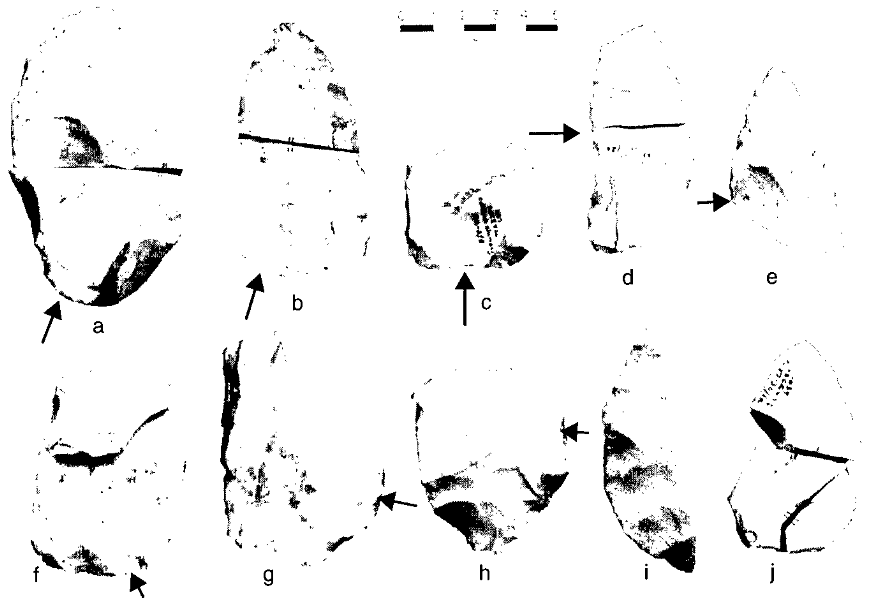


Figure 8.32. Late Paleoindian secondary-biface production failures: (a-c) end shock; (d-e) lateral shock; (f) end overshot (reverse hinge fracture); (g-h) side overshot; (i) longitudinal failure; (j) heat fracture. Arrows indicate direction of applied force.

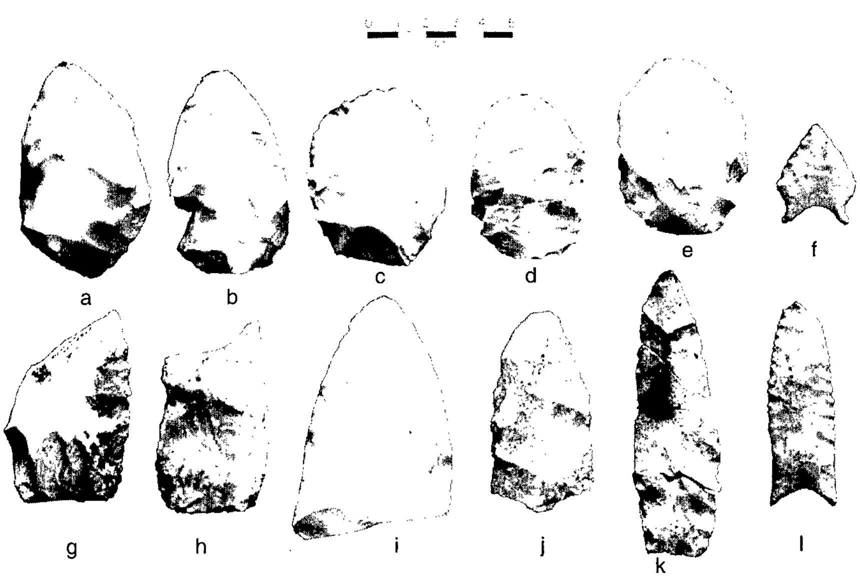


Figure 8.33. Late Paleoindian secondary bifaces/preforms: (a-e) probable San Patrice; (g-k) probable Dalton.

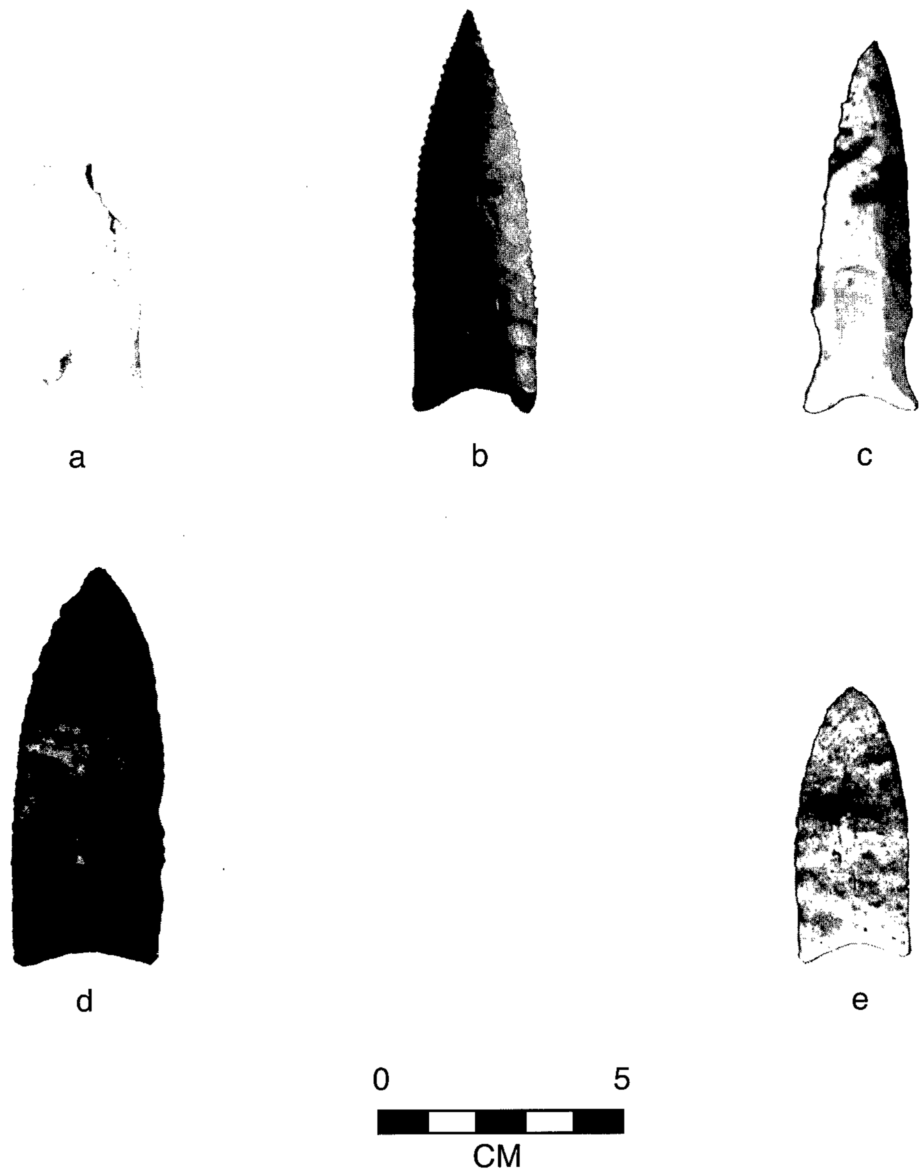


Figure 8.34. Late Paleoindian projectile points/knives: (a-b) Dalton Lanceolate; (c) Dalton variant (Breckenridge); (d-e) Plainview Lanceolate or initial-stage Dalton.

Ensor 1986). Their presence at the Big Eddy site on the northern fringe of their range suggests periodic forays into the western Ozarks and Sac River valley, possibly for the procurement of high-quality chert. The rich, high-quality chert resources of the Ozarks contrast dramatically with the chert-poor Gulf Coast and southeastern Plains regions (Banks 1990; Johnson 1989:25).

Three diagnostic San Patrice projectile points were recovered in situ in Blocks B and C in the upper portion of the 3Ab horizon. One is a Hope variety found in association with knapping Feature 28 in the southeast portion of TU 21 at a depth of 298 cm bs. Although probably resharpened, this complete point measures only 3.63 cm long. It exhibits faint, rounded shoulders, out-turned ears, a deeply concave base, and broad but shallow basal flutes (Figure 8.35a). It is nearly identical to a small point identified as a Hardaway point at the nearby Montgomery site (Collins et al. 1983:Figure 17c). The Montgomery San Patrice point was manufactured from exotic Pitkin chert found in northern Arkansas, whereas the Hope San Patrice point found at the Big Eddy site was made from local Oolitic Jefferson City chert. A small piece of charcoal found at the same depth (298 cm) within 20 cm of the Hope San Patrice point yielded a radiometric age of 10,185 ± 75 B.P. (AA-26653). This represents the first reliable radiocarbon date associated with San Patrice in the Midwest.

The other two small San Patrice dart points found in the 3Ab horizon are St. Johns variants. One (Figure 8.35b) was found at a depth of 291 cm in the northeast corner of TU 17, and the other (Figure 8.35c) was recovered from a depth of 297 cm in the east half of TU 18. St. Johns are similar to the Hope variety, except they exhibit shallow corner notches placed near the base, short barbs, and shallow, concave bases. This corner-notched variety, however, still exhibits short basal flutes on one or both faces. Both specimens were knapped from local Ellipsoidal Jefferson City chert. The recovery of these two St. Johns variants in proximity (1 cm and 7 cm vertical separation) to the Hope specimen argues for contemporaneity of the two San Patrice varieties, i.e., that the two styles simply represent a range of variation within the San Patrice type as opposed to the St. Johns variety representing a later, modified (corner notched) version of Hope San Patrice. Two St. Johns variety San Patrice points were recovered at Rodgers Shelter from Stratum II (Ahler 1971:10–11; Kay 1982e:501–505), which yielded dates ranging from 6300 ± 590 B.P. at the top to 8100 ± 140 B.P. at the bottom (Ahler 1971:6). Since these dates are much later than the Big Eddy date, as well as the 9,500–10,000-year-old dates from the Horn Shelter in Texas (cited in Johnson 1989:26), it is likely that the two Rodgers Shelter specimens were recovered from disturbed contexts.

Wilson

A fourth corner-notched hafted biface was found in TU 23 near Feature 40 at the base of an 8–10-cm-thick cultural (manuported) gravel deposit (Figure 8.18). This sealed context precludes any translocation via pedoturbation from younger (Early Archaic) deposits. Specifically, it was situated in the lower portion of the 3Ab horizon at a depth of 322 cm bs; however, this depth is approximately 10 cm lower than contemporary diagnostics found in other units due the dipping T1c stream bank in TU 23.

The biface is a large, knife-like form with a thick blade, corner notches, and a slightly concave base (Figure 8.35d). The base is lightly ground, but it does not exhibit the basal thinning or fluting typically found on San Patrice points. The distal end exhibits two small burin scars. Blade resharpening has produced bifacial bevelling as opposed to alternate bevelling. This corner-notched specimen is 5.38 cm long and 0.78 cm thick. Preliminary microscopic examination revealed that most of the blade edges had been bifacially resharpened prior to discard; however, at least three small relict (unresharpened) blade segments exhibited moderate edge crushing and rounding, probably indicative of heavy-duty cutting. Blade edges, however, are not serrated. The point was manufactured from an unidentified mottled gray chert (N 7/0, 6/0, 5/0) that appears to be exotic to the Ozarks. In color, it resembles Edwards chert from central Texas; however, it does not exhibit an orange tinge under ultraviolet light, a characteristic of Edwards chert (Michael Collins, personal communication 1998). It bears a greater resemblance to a mottled variety of Johns Valley chert found in southeast Oklahoma (Banks 1990:45–46).

In some ways, this specimen resembles the Kirk Corner Notched point type and in some respects it resembles Hardin Barbed. Neither of these types, however, adequately fit this hafted biface, nor do these types typically date to Late Paleoindian times. It most closely resembles a corner-notched type

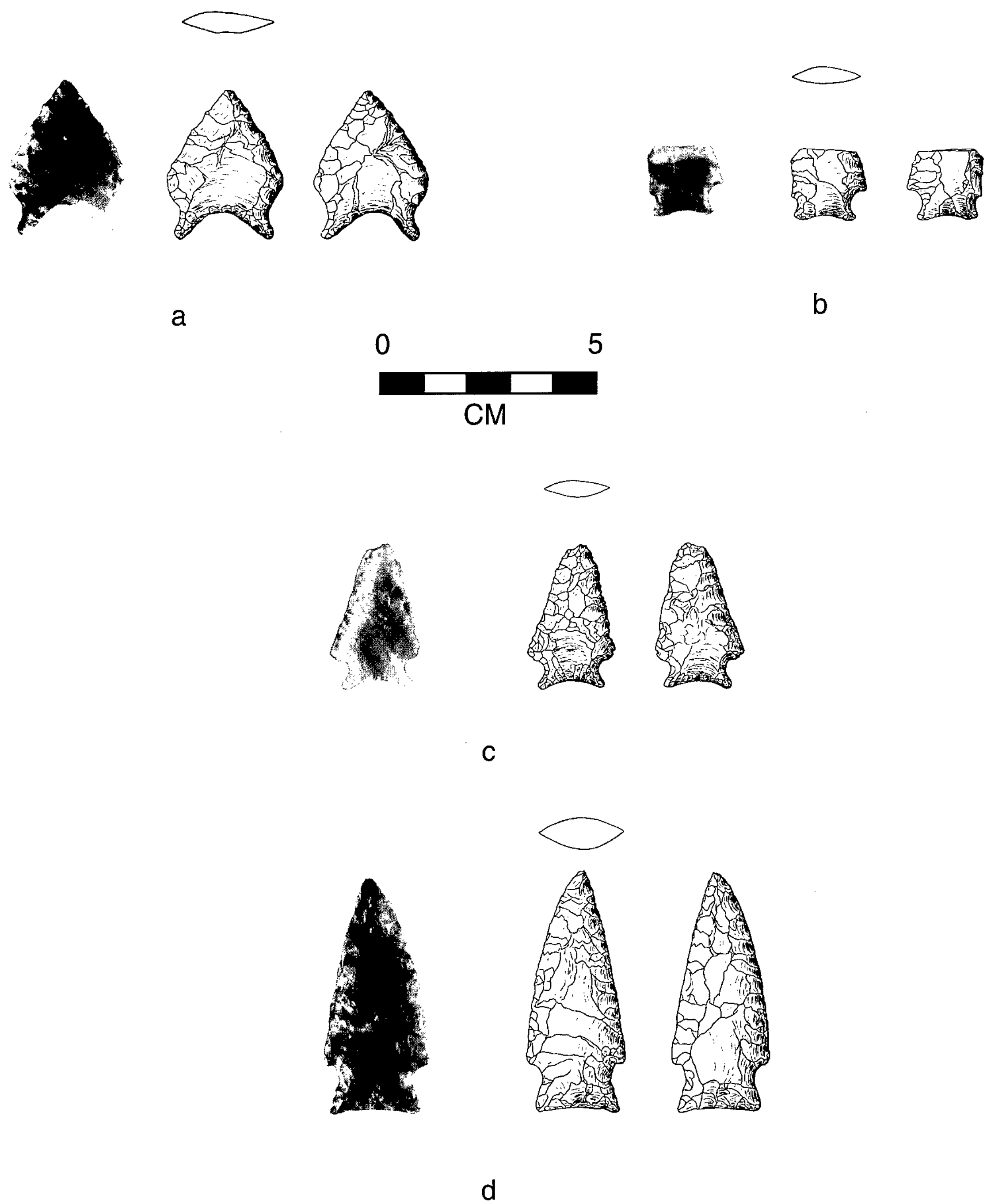


Figure 8.35. Late Paleoindian projectile points/knives. (a) San Patrice (Hope variety); (b-c) San Patrice (St. Johns variety); (d) Wilson.

first described in central Texas called Wilson (Weir 1985). Approximately 26 Wilson points recently were found in deposits dating to 10,000–9500 B.P. (uncalibrated) at the Wilson-Leonard site (Collins 1998:281; Holliday 1997:156). Wilson points are usually relatively thick in cross-section, bibevelled, and usually exhibit no basal thinning (Michael Collins, personal communication 1998). Based on these and other morphological attributes, the large corner-notched point found in the 3Ab horizon at Big Eddy is tentatively designated as a Wilson point (Collins 1998). The distribution of this newly named point type outside central Texas is not fully known. There are indications, however, that it may extend into the southwestern Ozarks. A similar corner-notched point was recovered from the lower levels (200 cm bs) of deep, stratified deposits in front of Moss Shelter (Stahle 1986:10, Figure 15aa) in northwest Arkansas. This specimen was reported before a formal description of the Wilson point was widely available. Unfortunately, no radiocarbon dates or other diagnostic artifacts were obtained from the lower levels at Moss Shelter to help establish a cultural affiliation. Four large, corner-notched, expanding-stemmed points found at the Montgomery site also resemble the Wilson type (Collins et al. 1983:52, Figure 16k-n). Three of these points were provisionally typed as "Montgomery Barbed" and one was classified as Hardin Barbed. These points need to be carefully re-examined and compared with attributes and measurements of Wilson points from the Wilson-Leonard site to determine if they actually match the Wilson type or are a variant thereof.

Dalton

Three Dalton points were recovered during the summer 1997 investigations; however, all three were found on the cutbank. The first Dalton point was found in the cutbank approximately midway between Blocks A and C at a depth of 328 cm bs (318 cm bs relative to Block B datum). In relation to the 3Ab horizon, it was located at the lower boundary near the shoulder of a topographic low or swale (Figure 8.36). This Dalton point was made from Oolitic Jefferson City chert, and it represents a finished projectile point/knife that was probably broken at the haft during use (Figure 8.37a). It exhibits multiple, long basal thinning scars (maximum 1.90 cm) on both faces. The second Dalton was found in the cutbank approximately 11 m south of Block C. It was discovered in situ at a depth of 288 cm bs (Block B datum) at the upper boundary of the 3Ab horizon (Figure 8.36). This Dalton point, which was manufactured from Ellipsoidal Jefferson City chert, exhibits a transverse break and also appears to have broken at the haft during use (Figure 8.37b). Unlike the previous specimen, however, this Dalton point exhibits no basal thinning. The third Dalton point was found out of context on the cutbank approximately 60 m east of Block B. It was manufactured from Burlington chert and is nearly complete (Figure 8.37c). It exhibits at least two small burin scars on the distal end.

All three of the Dalton points exhibit light to moderate grinding along the lateral and basal margins. Two have deep (0.66–0.64 cm) basal concavities, whereas the concavity is rather shallow (0.37 cm) on the third. Basal thinning is variable; the Oolitic Jefferson City specimen has four basal thinning scars on both faces, the Ellipsoidal Jefferson City specimen exhibits no basal thinning, and the Burlington specimen has two thinning scars on one side only. All three of the Dalton points are relatively thin, ranging from 0.53 to 0.71 cm. Only one of the three points has an intact blade. It appears to have been resharpened slightly, but it is not bevelled. Bevelling on the other two basal fragments is indeterminate.

The author recently had an opportunity to examine the Rodgers Shelter Dalton points curated at the Illinois State Museum. The three Big Eddy Dalton points described above compare favorably with at least some of the Dalton points recovered from Rodgers Shelter (Figure 8.38). Kay (1982e:494–500) defined four categories of Dalton points: Category 10 (fluted lanceolate), Category 21 (Dalton-like), Category 22 (Dalton), and Category 23 (Plainview). Others, including the author, however, see all of these Rodgers Shelter specimens simply as variations within the Dalton point tradition (Chapman 1975:75; O'Brien and Wood 1998:85; Bruce McMillan, personal communication 1998). Nevertheless, there could be temporal distinctions within the Dalton sample from Rodgers Shelter. For example, the thin, nonbevelled, lanceolate specimens in Categories 10 and 23 might represent early Dalton forms, whereas the thicker, bevelled, strong-shouldered specimens (Categories 21 and 22) might be later or terminal Dalton forms. Unfortunately, the Dalton points were recovered from several horizons (i.e., Late Paleoindian through Middle Archaic), indicating some mixing of the early deposits

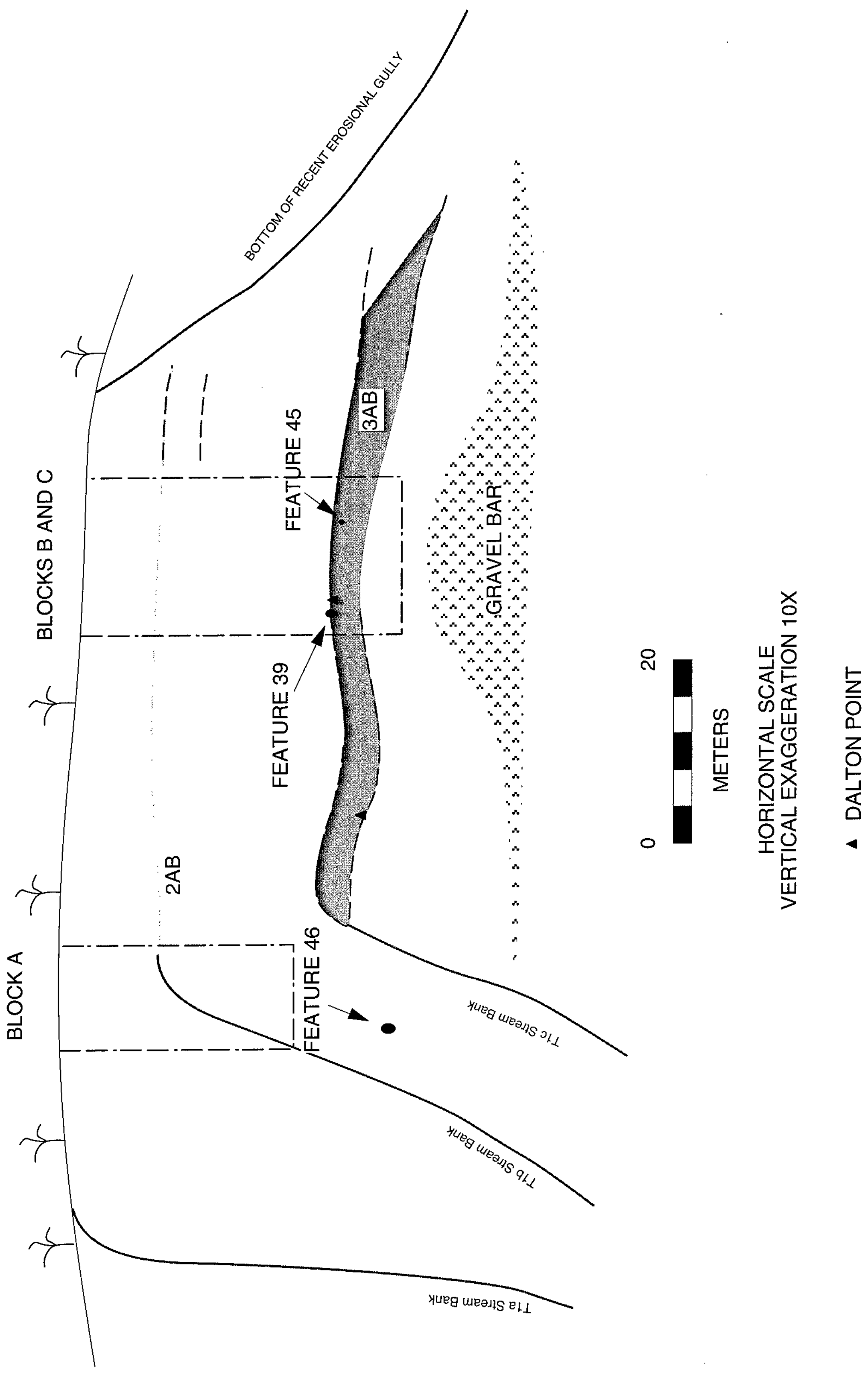


Figure 8.36. Cutbank profile showing locations of in situ Dalton points and Features 39, 45, and 46.

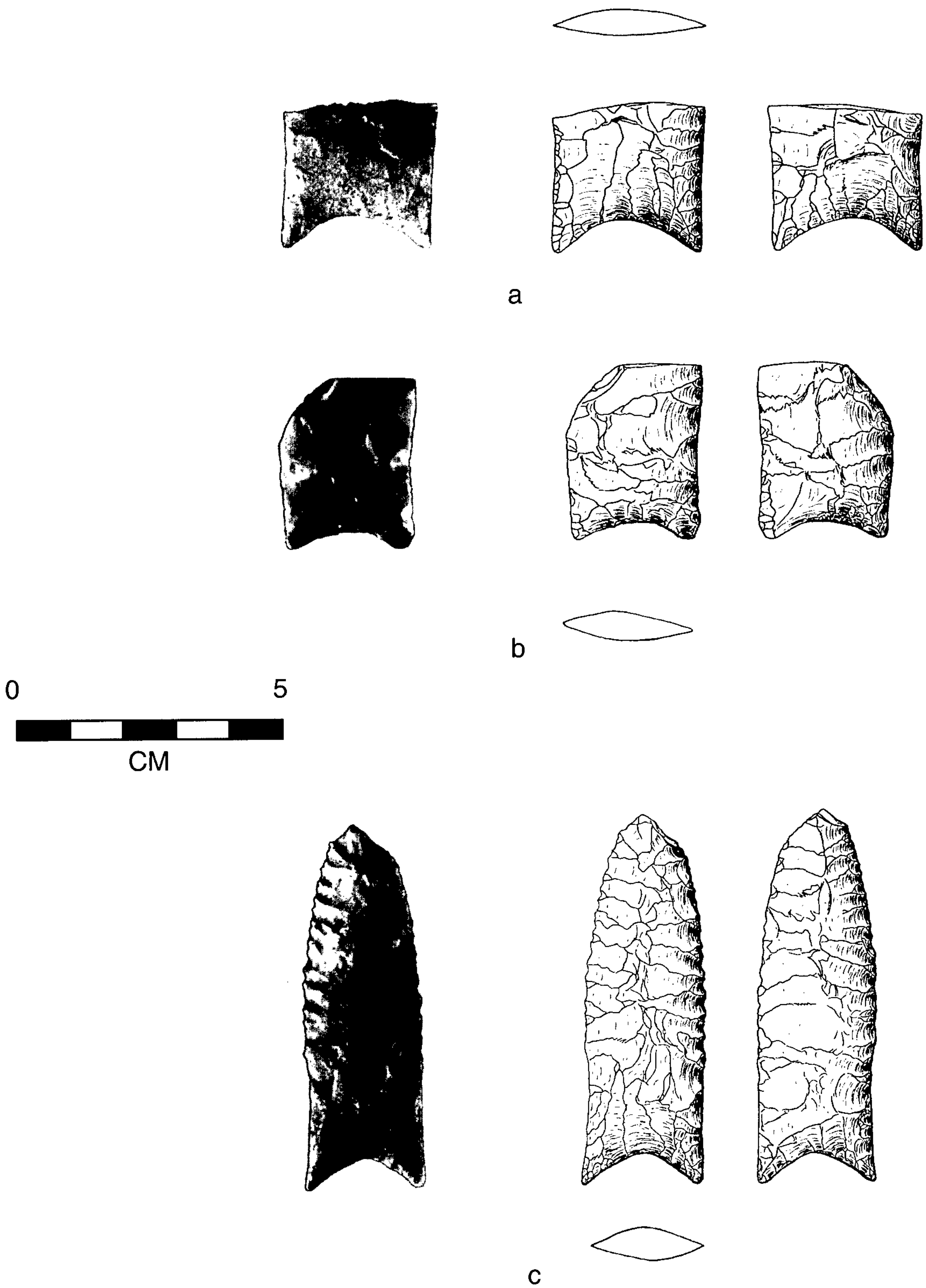


Figure 8.37. Late Paleoindian Dalton projectile points/knives from the Big Eddy site.

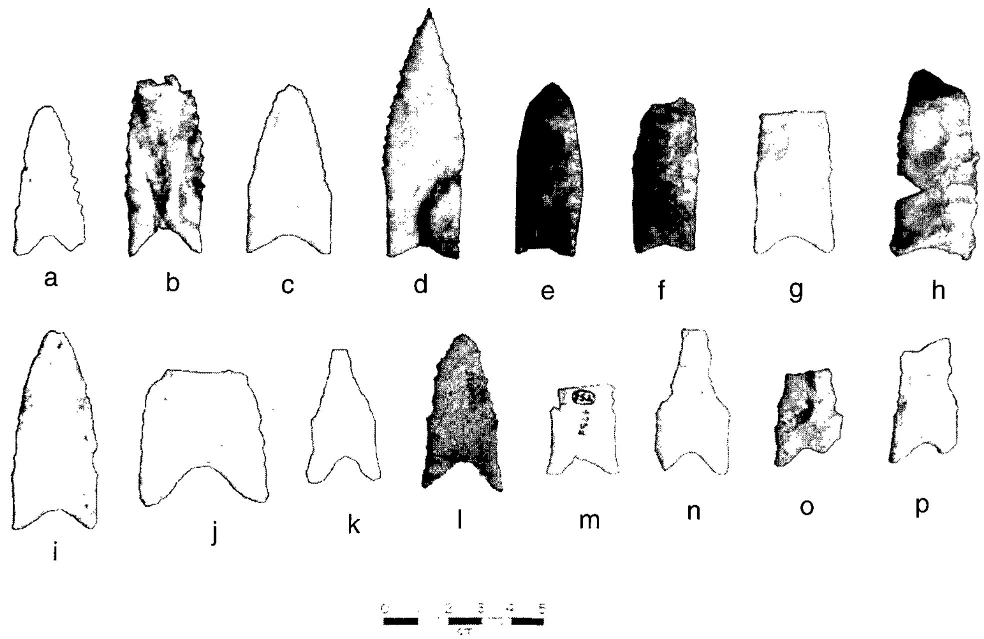


Figure 8.38. Late Paleoindian Dalton points from Rodgers Shelter (photographed by author from Illinois State Museum collection).

(Kay 1982e:497–500, 1982d:102; O'Brien and Wood 1998:85–86). In any event, Categories 10 and 23 most closely resemble the Big Eddy Dalton points.

A comparison can also be made with the 39 Dalton points recovered from the Montgomery site. Collins et al. (1983:Table 1) report that most of these (92%) exhibit bevelled blades, all of which were right-hand bevels (viewed from the proximal end). Thicknesses range from 6 to 9 mm with an average of 7.1 mm, which is slightly thicker than the Big Eddy specimens (Table 8.8). Three specimens, however, were noted to be slightly different, having Plano-like lanceolate forms (Collins et al. 1983:31). These appear to be most similar to the Big Eddy specimens. Although a larger sample of Dalton points needs to be obtained from the Big Eddy site, there is some indication that thin, nonbevelled, lanceolate Daltons are early forms, and that thicker, strongly bevelled Daltons (e.g., the majority found at the Montgomery site and the Dalton-like Graham Cave found at Big Eddy) may be later forms.

In addition to San Patrice, Wilson, and Dalton, it is possible that another Late Paleoindian point type is present in the 3Ab horizon. This type is represented by two lanceolate points that have been tentatively classified as Plainview (Figure 8.34d-e), though they may in fact be initial-stage Dalton points. Unfortunately, both specimens were found out of context by local collectors. Plainview points are similar in form to Clovis points but do not exhibit flute scars (Justice 1987:30). Like most Dalton points, however, they do have basal thinning-flake scars (Hofman 1996:64). Other than grinding, there is no delineation between blade and stem. The larger point (Figure 8.34d), which was manufactured from exotic Lower Reeds Spring chert, appears to be the best fit for the Plainview type. It exhibits a Clovis-like shape and moderate basal and lateral grinding. It is 2.9 cm wide at the base. It is possible, however, that it could be an unresharpened Dalton point similar to the large, initial-stage Dalton points recovered from the Sloan site (Morse 1997:18, Figure 3.2). The smaller specimen (Figure 8.34e) exhibits a slightly incurvate stem as well as limited basal thinning; it actually falls within the range of variability of Dalton points.

In the southern Plains area, Plainview points are generally regarded as Late Paleoindian (Hof-

man 1996:64; Holliday et al. 1983:174–175; Justice 1987:30; O'Brien and Wood 1998:85), and Reagan (1981:18) has even suggested a technological continuum between Plainview and Dalton. Goshen-Plainview in the northern Plains, however, is believed to predate Folsom and Dalton (O'Brien and Wood 1998:85). Relatively few Plainview points have been found in Missouri. Kay (1982e:497–500), however, classified two lanceolate points from the lower levels of Rodgers Shelter as Plainview (Figure 8.38g-h) and characterized three other points as fluted lanceolates Figure 8.38d-f). Although subtle in some of these specimens, all exhibit a well-defined stem-blade juncture (with slightly incurvate stem edges) and other attributes typical of Dalton points (Chapman 1975:75; O'Brien and Wood 1998:85).

Potentially Diagnostic Dalton and San Patrice Tools

It appears that several additional tools found in the Late Paleoindian horizon can be assigned to the Dalton or San Patrice components based on key attributes. At least one drill and a few secondary-biface preforms appear to be associated with the San Patrice component. For example, the drill with the bulbous-shaped base (Figure 8.25o) exhibits a wide and a broad basal flake scar reminiscent of basal fluting on San Patrice dart points. A similar bulbous-based drill was part of a San Patrice tool assemblage from the John Pearce site (Webb et al. 1971:Figure 8l). This drill appears to be unlike typical Dalton drills, which are usually recycled/reworked Dalton points or T-shaped (Ahler and McMillan 1976:Figure 10.8l-o; Chapman 1975:109–121; Collins et al. 1983:Figure 17m-n; Goodyear 1974:Figure 11r-w; Morse 1971:Figure 1k-n; Price and Krakker 1975:Figure 6f-h).

End scrapers are difficult to differentiate. Although San Patrice end scrapers are generally small, averaging approximately 2.3–2.7 cm in length (Ensor 1985:Table 9; Webb et al. 1971:Table 8), exhausted Dalton end scrapers can be easily confused with San Patrice end scrapers. Nevertheless, it appears that certain large end scrapers with a particular morphology can be tentatively associated with Dalton. For example, the majority of Dalton end scrapers are often 4.0 cm or larger (Ahler and McMillan 1976:Figure 10.6n-o; Goodyear 1974:Figure 15; Price and Krakker 1975:Figure 6a-d). The key difference appears to be the presence (Dalton) or absence (San Patrice) of an elongated proximal end for hafting. Several end scrapers recovered from the Dalton horizon at Rodgers Shelter (Figure 8.28b-f) and the Montgomery site (Collins et al. 1983:Figure 18a-b) exhibit elongated stems. Several end scrapers from the Sloan site (Morse 1997:Figure 3.14, rows 1–2) exhibiting little or no resharpening also exhibit elongated haft elements. At the Big Eddy site, three examples of these long end scrapers were recovered from cutbank deposits (Figure 8.25g, k-l). Two other large scrapers (Figure 8.25h-i) were recovered from the southern portion of Blocks B-C in association with knapping features.

The small adzes (Figure 8.25m-n) found on the cutbank may be attributable to the Dalton component. Johnson (1989:22) states that no adzes have ever been associated with San Patrice assemblages, although one small adze was found at the Joe Powell site (Ensor 1985:Figure 8f). On the other hand, adzes have been characterized as an integral part of Dalton assemblages (Goodyear 1974; Johnson 1989; Morse 1971; Morse and Goodyear 1973).

Differences in San Patrice and Dalton biface reduction also appear to be evident in workshop debris from Blocks B-C. These differences are most apparent in the size and shape of the preform failures. Several preforms found in the upper levels of the 3Ab horizon (292–300 cm bs) are small forms that are round to oval in shape (Figure 8.33a-e). They range in size from 5.68 to 7.65 cm in length and 3.99 to 4.64 cm in width. These appear to be preforms for the manufacture of small dart points such as San Patrice. Most San Patrice points (including the three specimens from Big Eddy) are small, ranging in size from approximately 2.0 to 4.0 cm (Duffield 1963:91–93; Ensor 1985:Table 8; Webb et al. 1971:Table 6). On average, San Patrice points are one-third to one-half the size of Dalton points (O'Brien and Wood 1998:133). Even the largest San Patrice points, which represent unresharpened first-stage specimens, are rarely over 6.0 cm in length (Johnson 1989:Figure 11). One unresharpened San Patrice–like point collected by Dan Long in central Cedar County, Missouri, measured 6.5 cm long.

In contrast, Dalton preforms tend to be much longer and lanceolate in shape with a squared base, as illustrated by several preforms recovered from the Montgomery site (Collins et al. 1983:Figure 18k-n), the Dalton levels at Rodgers Shelter (Figure 8.39), the Brand site (Goodyear 1974:Figure 11a), the Sloan site (Morse 1997:35), and the Hawkins

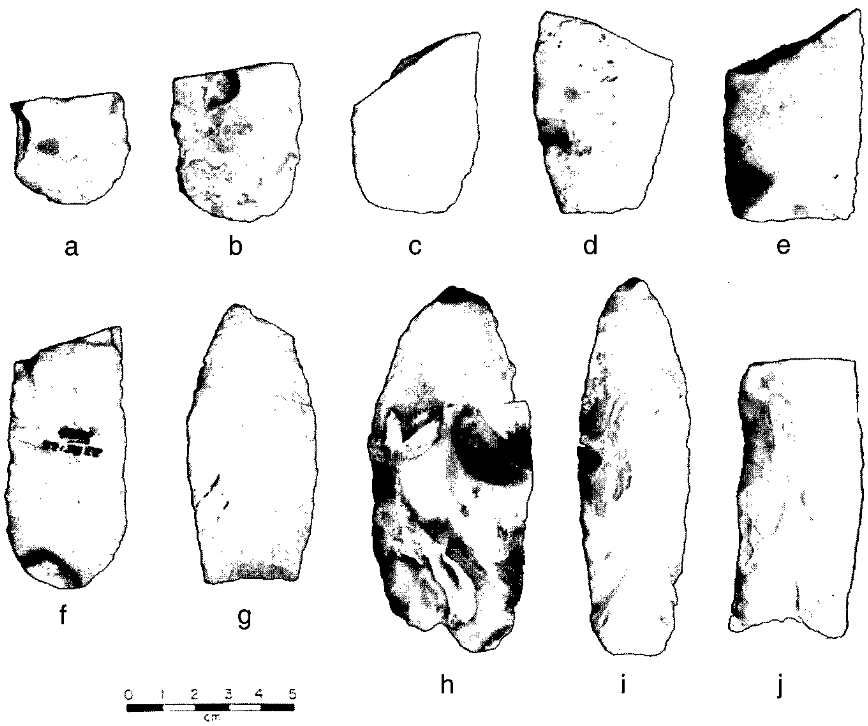


Figure 8.39. Dalton secondary bifaces from Rodgers Shelter: (a-f) end/lateral shock failures; (g-i), refit specimens; (j) preform (photographed by author from Illinois State Museum collection).

cache site (Morse 1971:Figure 2). Similar long preforms with broad blades and squared bases were found at the Big Eddy site (Figure 8.33g-k). These secondary bifaces, especially the shattered biface illustrated in Figure 8.33k, almost certainly represent Dalton production failures. Specimens g-h are proximal fragments and specimens i-j are distal fragments, all of which were broken approximately at the midpoint of the preform. Even these fragments are equal to or longer than the whole specimens described above as probable San Patrice preforms.

Other probable Dalton preform failures include two proximal fragments (Figure 8.27d and see Figure 9.3i) and two distal fragments (Figures 8.27c and 8.32e). Finally, two refitted (medial and distal) fragments of a tertiary biface, which exhibit a moderate left bevel (Figure 8.27b), are probably from a broken Dalton projectile point/knife.

Dalton points are highly variable in length (4–17 cm) due to the extensive resharpening that typically accompanied the later stages of their use-life (Chapman 1975:245; Goodyear 1974). The length of unbroken Dalton points recovered from the Montgomery site ranges from 5.6 to 14.1 cm, and Daltons from Rodgers Shelter range in length from 4.8 to 7.8 cm (Collins et al. 1983:40–43; Kay 1982e:497–499). The upper end of these length ranges is more representative of initial-stage Daltons, i.e., newly completed preforms. Initial-stage or unresharpened Dalton points found at the Sloan site ("large Dalton") range from 8.1–14.7 cm (Morse 1997:22), and unresharpened points in the Hawkins cache range from 6.0–7.8 cm (Morse 1971:Table 1, Group A). Accordingly, most of the small, ovoid preforms represented in Figure 8.33a-e are far too short for the production of Dalton Lanceolate points (especially Figure 8.33c-e specimens), and therefore, probably represent San Patrice preforms. Conversely, the large lanceolate-shaped preforms with squared bases (Figure 8.33g-k) are probably Dalton preforms.

It should be pointed out that some of the smallest preforms (Group B) found in the Hawkins cache (Morse 1971:Figure 2d-g) and at the Sloan site (Morse 1997:Figure 3.13, row 5) are smaller than the proposed San Patrice preforms from the Big Eddy site. The Hawkins cache site and the Sloan site, however, are located in northeast Arkansas where chipped-stone raw materials are relatively scarce and usually occur as small, redeposited cobbles. Although raw material was not identified in the Hawkins cache specimens, most were probably manufactured from Lafayette chert cobbles obtained from the nearby Crowley's Ridge. All but a few of the 92 preforms found at Sloan were knapped from Lafayette (Crowley's Ridge) chert (Morse 1997:30). The majority of Lafayette chert cobbles are only 5–7 cm in diameter (Ray 1998), which is a limiting factor in the production of sizeable preforms. In contrast, cherts in the western Ozarks (e.g., Jefferson City, Chouteau, and Burlington) occur in much larger nodules and cobbles. Raw-material size, therefore, was not a limiting factor in the manufacture of preforms at the Big Eddy site as it was in the Mississippi alluvial lowland of northeast Arkansas.

Other Lithics

A total of 310 nonchipped-stone artifacts was recovered from the Late Paleoindian horizon (Table 8.2). Most of these other-lithic artifacts consist of chert shatter and fire-cracked rock. The bulk of the shatter represents flawed chert cobbles (Jefferson City, Burlington, and Chouteau) that disintegrated along incipient fracture planes during lithic reduction. Although not common, at least 136 fragments of highly oxidized fire-cracked rock were recovered from the Late Paleoindian horizon. Practically all of the fire-cracked rock was composed of small to medium-sized alluvial gravel similar to that found in manuported gravel piles (see below). Based on the presence of fire-cracked rock, it is apparent that at least some of the river gravel incorporated into the Late Paleoindian levels was heated. Although it is possible that some of the heated rock was incidental or accidental to hearth construction, it is probable that the majority of the rock heating was intentional, possibly for food preparation. Over 77% of the alluvial gravel was identified as Burlington chert and approximately 17% was Jefferson City chert, with the remainder Chouteau chert and Northview siltstone. It is interesting to note that these raw-material percentages are very similar to those found naturally in the gravel bars of the Sac River (see Chapter 9).

At least 12 pieces of pigment rock or iron ore were recovered from the Late Paleoindian horizon. Of these 12 pieces, nine are hematite and three are limonite. Most are very small fragments (<1.0 g); however, three large limonite chunks weigh 2.35 g, 3.55 g, and 5.97 g, and one hematite piece that weighs 43.5 g exhibits scratched and cut areas on two faces. The iron ore fragments were found in at least five different test units across Blocks B-C and were distributed throughout the 3Ab horizon, although they appeared to be concentrated in Levels 31 and 32. Iron ore or ochre deposits have been associated with Dalton components at several sites in the Midwest, including Sloan (Morse 1997:51), Rodgers Shelter (Ahler and McMillan 1976; Behm 1982), Jens (Walthall and Holley 1997), Graham Cave (Chapman 1975:105–109), and Olive Branch (Gramly 1995). In addition to other uses, Walthall and Holley (1997:158) make a case that ochre may have even played a role in the processing and painting of hides.

Ten ground-stone tools were found in the Late Paleoindian deposits. Most are abraders made from local sandstones and siltstones. Three are flat abraders with one to four faceted surfaces each, and four are grooved abraders with one or multiple grooves and/or striations. Morse (1973:28) reported that flat abraders were the most common type of Dalton abrader in northeast Arkansas. One large grooved sandstone abrader, found on top of a gravel feature in TU 23, exhibits one broad and deep U-shaped groove on each face with multiple shallow V-shaped grooves around the larger grooves as well as on two ends of the abrader (Figure 8.25p). It compares favorably with two grooved abraders found in a Dalton cache in northeast Arkansas (Morse 1971:18–19), as well as grooved abraders found at the Brand site (Goodyear 1974:72) and the Sloan site (Morse 1997:46–47). Although the grooved abrader may have several functions, the narrow V-shaped grooves indicate that the hand-sized rock composed of medium-coarse sandstone was utilized relatively extensively as a platform-preparation abrader during the manufacture of bifacial tools. Another grooved siltstone abrader exhibiting multiple fine striations may have been used for late-stage platform preparation or some other undetermined activity. The other Late Paleoindian ground-stone tools consist

of one Burlington chert cobble used as a light-duty hammerstone, one sandstone mano exhibiting one lightly ground surface, and a small battered pebble (2.84 cm long by 1.92 cm wide) of indeterminate function.

Features

A number of features were investigated during the excavation of the 3Ab horizon in Blocks B-D. These included two poorly-defined burn features, several well-defined lithic features, and a few round or amorphous piles of alluvial gravel. Each is described separately below.

Burn Features

The two burn features (Features 34 and 35) were located approximately 1 m apart in the western portion of Block C (Figure 8.40). In plan view, these two features resembled prehistoric hearths with dispersed and concentrated areas of burned (highly oxidized) soil and associated bits of what appeared to be humified wood. A 9-liter flotation sample was removed from each feature; however, no plant remains were recovered by flotation. Cross-sectioning revealed very diffuse edges with no clear boundary. The depth range of the smaller and more diffuse Feature 34 was estimated to be 300–314 cm bs, whereas the concentrated portion of Feature 35 was estimated to be 287–307 cm bs with diffuse burned soil extending to 327 cm bs. Although common in surrounding areas, only a sparse scatter of flakes appeared to be associated with the two burn features. The combined evidence indicates that Features 34 and 35 represent the remains of one or two natural burns, probably of tree stumps and/or roots.

Burn features are relatively common in the alluvial fills at the Big Eddy site and in alluvial formations in the Sac River valley in general. In the early submember at Big Eddy, three burn features were identified in the cutbank and two more were defined in the south wall of TU 8 (Figure 8.18). All five burn features were situated within the 3Ab horizon or extended into the underlying 3Btb1 horizon. One of these features, located in the cutbank south of Block C, was excavated and designated Feature 39 (Figure 8.36). More than 10 g of wood charcoal were recovered from this burn feature at a depth of 284–286 cm bs, which is located at the contact between the middle and early submembers at the top of the 3Ab horizon. Feature 39 yielded a radiocarbon age of 9190 ±90 B.P. (Beta-112982), which appears to be too late compared to other dates obtained from above and within the 3Ab horizon (see Table 7.1). This late date, however, might be a result of dating a deep tap root of a tree living on a higher (younger) middle submember surface.

Another burn feature, designated Feature 46, was discovered in the cutbank south of Block A in the lower portion of the middle submember at a depth of 345–350 cm bs (Figure 8.36). Charcoal excavated from this natural burn feature yielded a date of 8110 ± 140 B.P. (Beta-117781). Unfortunately, no artifacts were found during the excavation of this feature or in TU 7 in Block A, which was dug to a depth of 380 cm (middle Rodgers shelter submember). In addition to the above cutbank features, several other burn features were identified in the middle to upper portions of the late submember during the excavation of Block A. These features were found in Late Archaic levels (150 cm bs) up to the base of the plow zone (25 cm bs). Numerous burn features have been noted at various depths during reconnaissance cutbank surveys at various other sites in the Sac River valley, including 23CE238, 23CE239, 23CE412, and 23CE492.

Knapping Features

Sixteen lithic features were recorded in the 3Ab horizon in Blocks B-D. Each has been characterized by size, depth, and other criteria in Table 8.10. Thirteen were found in Blocks B and C with the majority clustered in the southern half (Figure 8.40). Of the remaining three lithic features, two were discovered in Block D (Figure 8.30) and one was found in the eroded cutbank. Feature contents are divided into debitage and tools in Table 8.11. The flake debitage is divided by size grades in Table 8.12, and classified by flake type and individual cobbles in Table 8.13.

All 16 features represent lithic-reduction or knapping-debris scatters of various sizes and artifact densities. These lithic features are interpreted as collected piles of knapping debris (presumably swept piles or dump piles); most exhibited a mounded profile and measured only 20–40 cm in diameter. They represent the end products of discrete episodes in the reduction of one or more chert cobbles. Detailed raw-material analyses of the debitage and broken preforms enabled the delineation of distinct chert cobbles and refit specimens. The

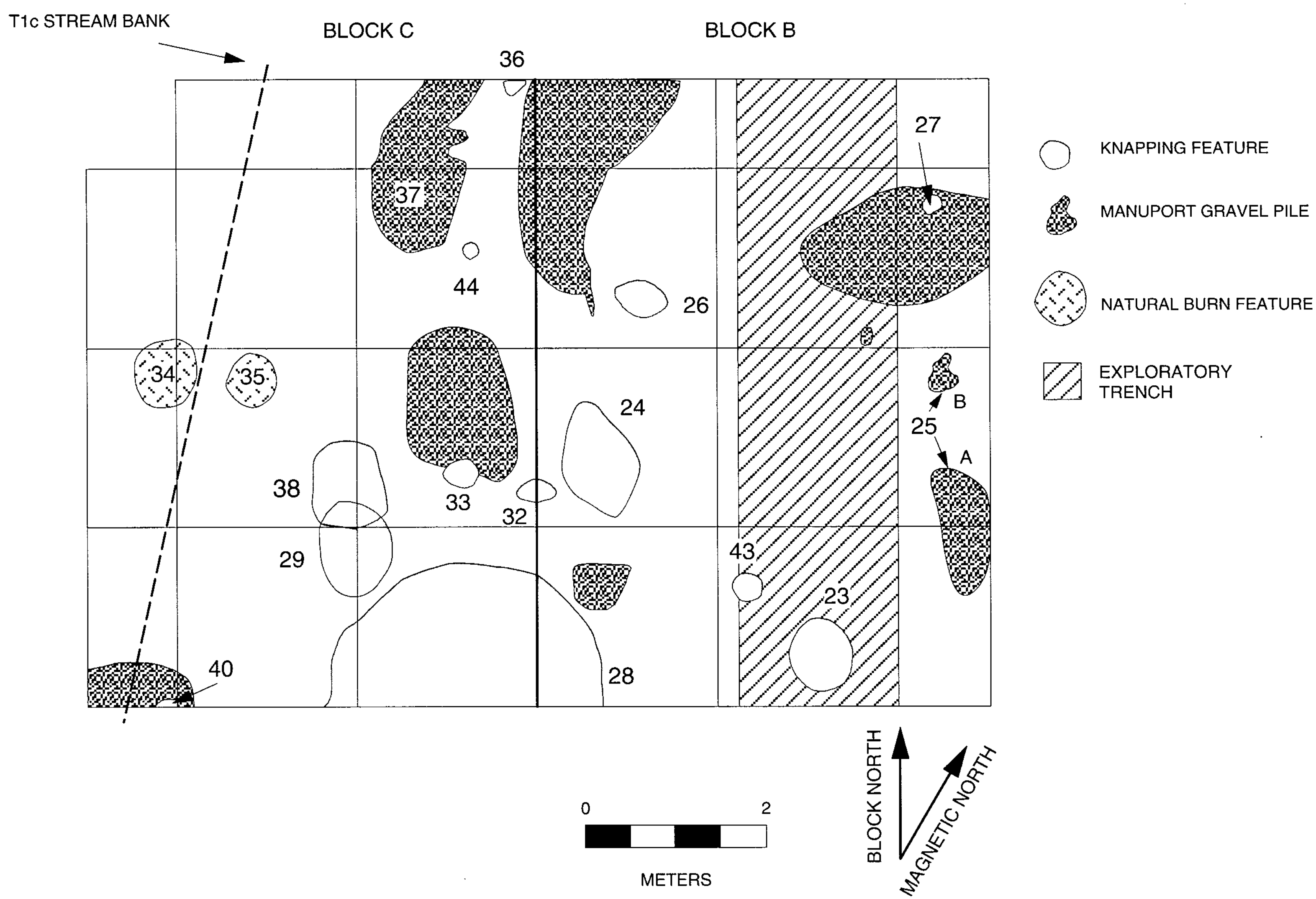


Figure 8.40. Plan view of knapping features, gravel piles, and natural burn features in the Late Paleoindian horizon of Blocks B and C.

Table 8.10. Knapping-Feature Data.

Feature	Size (cm)	Depth (cm)	3Ab Section	Number of Cobbles
23	50 x 80	295–302	Middle	5
24	85 x 130	304–308	Middle	2
26	40 x 60	298–301	Middle	≥12
27	22 x 22	293–296	Upper	2
28	160+ x 300	293–304	Middle	≥46
29	80 x 110	301–307	Middle	≥8
32	24 x 40	298–301	Middle	≥5
33	34 x 38	299–306	Middle	≥8
36	14+ x 25	303–308	Middle	≥8
38	75 x 100	310–315	Lower	≥15
40	12+ x 25	316–320	Lower	1
41	40 x 44	308–312	Lower	1
42	20 x 30	305–308	Middle	3
43	30 x 35	303–306	Middle	1
44	20 x 20	304–305	Middle	1
45	? x 15	304–305	Middle	3

Table 8.11. Tools and Debitage in Knapping Features.

	Debitage		Tools[a]		Total	
Feature	N	%	N	%	N	%
23	46	1.7			46	1.6
24	116	4.2			116	4.2
26	94	3.4	2	6.9	96	3.4
27	21	0.8			21	0.8
28	1,387	50.3	19	65.5	1,406	50.4
29	108	3.9	2	6.9	110	3.9
32	64	2.3			64	2.3
33	118	4.3			118	4.2
36	34	1.2	2	6.9	36	1.3
38	197	7.1	1	3.4	198	7.1
40	278	10.1			278	10.0
41	33	1.2	1	3.4	34	1.2
42	125	4.5	1	3.4	126	4.5
43	58	2.1			58	2.1
44	66	2.4			66	2.4
45	14	0.5	1	3.4	15	0.5
Total	2,759	100.0	29	100.0	2,788	100.0

[a]Refit items count as one tool.

Table 8.12. Knapping Features by Flake Size Grade.

	Flake Size Grade[a]													
	1		2		3		4		5		6		Total	
Feature	N	%	N	%	N	%	N	%	N	%	N	%	N	%
23			33	71.7	10	21.7	3	6.5					46	100.0
24			75	64.7	34	29.3	6	5.2	1	0.9			116	100.0
26	3	3.2	54	57.4	27	28.7	7	7.4	1	1.1	2	2.1	94	100.0
27	4	19.0	15	71.4	2	9.5							21	100.0
28[b]			771	68.8	240	21.4	75	6.7	28	2.5	7	0.6	1,121	100.0
29			83	76.9	20	18.5	3	2.8	1	0.9	1	0.9	108	100.0
32			51	79.7	13	20.3							64	100.0
33			89	75.4	23	19.5	2	1.7	1	0.8	3	2.5	118	100.0
36	1	2.9	29	85.3	3	8.8	1	2.9					34	100.0
38			138	70.1	41	20.8	14	7.1	3	1.5	1	0.5	197	100.0
40	118	42.4	117	42.1	30	10.8	9	3.2	4	1.4			278	100.0
41			20	60.6	6	18.2	3	9.1	3	9.1	1	3.0	33	100.0
42	51	40.8	61	48.8	10	8.0	3	2.4					125	100.0
43	25	43.1	26	44.8	6	10.3	1	1.7					58	100.0
44	5	7.6	43	65.2	16	24.2	2	3.0					66	100.0
45			6	42.9	6	42.9	2	14.3					14	100.0
Total	207	8.3	1,611	64.6	487	19.5	131	5.3	42	1.7	15	0.6	2,493	100.0

[a]See Figure 6.9 for size grades.
[b]Only flakes from numbered cobbles were size graded for this feature.

Table 8.13. Feature Cobbles by Flake Type.

	Primary Flake		Secondary Flake		Tertiary Flake		Biface Flake		Flake Fragment		Total	
Cobble[a]	N	%	N	%	N	%	N	%	N	%	N	%
Feature 23												
23-01			2	14.3	1	7.1	7	50.0	4	28.6	14	100.0
23-02	5	26.3	1	5.3			5	26.3	8	42.1	19	100.0
23-03			2	40.0			1	20.0	2	40.0	5	100.0
23-04			2	40.0			1	20.0	2	40.0	5	100.0
23-05									3	100.0	3	100.0
Total	5	10.9	7	15.2	1	2.2	14	30.4	19	41.3	46	100.0
Feature 24												
24-01	2	8.3	2	8.3	1	4.2	5	20.8	14	58.3	24	100.0
24-02	5	5.4	3	3.3			53	57.6	31	33.7	92	100.0
Total	7	6.0	5	4.3	1	0.9	58	50.0	45	38.8	116	100.0
Feature 26												
26-01							1	25.0	3	75.0	4	100.0
26-02									3	100.0	3	100.0
26-03	1	4.0	2	8.0	2	8.0	3	12.0	17	68.0	25	100.0
26-04					2	22.2	2	22.2	5	55.6	9	100.0
26-05			3	42.9			1	14.3	3	42.9	7	100.0
26-06							1	25.0	3	75.0	4	100.0
26-07							2	100.0			2	100.0
26-08									3	100.0	3	100.0
26-09	1	33.3	1	33.3					1	33.3	3	100.0
26-10	1	14.3	1	14.3			2	28.6	3	42.9	7	100.0
26-11			1	14.3			2	28.6	4	57.1	7	100.0
26-12							1	33.3	2	66.7	3	100.0
26-U-Ojcc-b									2	100.0	2	100.0
26-U-Ojcc-e							4	26.7	11	73.3	15	100.0
Total	3	3.2	8	8.5	4	4.3	19	20.2	60	63.8	94	100.0
Feature 27												
27-01			1	14.3			3	42.9	3	42.9	7	100.0
27-02							7	50.0	7	50.0	14	100.0
Total			1	4.8			10	47.6	10	47.6	21	100.0
Feature 28												
28-01					1	7.7	7	53.8	5	38.5	13	100.0
28-02			2	10.0			10	50.0	8	40.0	20	100.0
28-03			3	20.0			11	73.3	1	6.7	15	100.0
28-04					2	40.0	2	40.0	1	20.0	5	100.0
28-05							8	72.7	3	27.3	11	100.0
28-06			1	50.0					1	50.0	2	100.0
28-07							24	45.3	29	54.7	53	100.0
28-08							4	33.3	8	66.7	12	100.0
28-09	1	50.0	1	50.0							2	100.0
28-10							4	66.7	2	33.3	6	100.0
28-11							3	75.0	1	25.0	4	100.0
28-12							3	100.0			3	100.0
28-13									2	100.0	2	100.0
28-14							2	100.0			2	100.0
28-15			1	50.0					1	50.0	2	100.0

Table 8.13. Feature Cobbles by Flake Type. (Continued).

	Primary Flake		Secondary Flake		Tertiary Flake		Biface Flake		Flake Fragment		Total	
Cobble[a]	N	%	N	%	N	%	N	%	N	%	N	%
28-16									2	100.0	2	100.0
28-17							1	50.0	1	50.0	2	100.0
28-18			2	50.0					2	50.0	4	100.0
28-19							1	50.0	1	50.0	2	100.0
28-20	1	50.0							1	50.0	2	100.0
28-21					1	50.0			1	50.0	2	100.0
28-22							4	100.0			4	100.0
28-23							1	50.0	1	50.0	2	100.0
28-24							1	50.0	1	50.0	2	100.0
28-25			2	100.0							2	100.0
28-26			2	33.3	1	16.7	1	16.7	2	33.3	6	100.0
28-27							4	57.1	3	42.9	7	100.0
28-28							1	50.0	1	50.0	2	100.0
28-29							31	50.0	31	50.0	62	100.0
28-30							2	100.0			2	100.0
28-31	1	7.1	2	14.3			7	50.0	4	28.6	14	100.0
28-32			3	50.0	1	16.7	2	33.3			6	100.0
28-33			1	50.0					1	50.0	2	100.0
28-34			2	66.7					1	33.3	3	100.0
28-35							1	50.0	1	50.0	2	100.0
28-36	2	100.0									2	100.0
28-37			2	100.0							2	100.0
28-38							1	50.0	1	50.0	2	100.0
28-39									3	100.0	3	100.0
28-40	1	50.0							1	50.0	2	100.0
28-41			2	16.7	1	8.3	3	25.0	6	50.0	12	100.0
28-42			2	6.3			12	37.5	18	56.3	32	100.0
28-43							2	66.7	1	33.3	3	100.0
28-44			2	25.0			3	37.5	3	37.5	8	100.0
28-45			2	66.7					1	33.3	3	100.0
28-46					1	50.0	1	50.0			2	100.0
28-U-Mbk	2	6.1	6	18.2			12	36.4	13	39.4	33	100.0
28-U-Mch	1	1.0	2	1.9	2	1.9	50	48.1	49	47.1	104	100.0
28-U-Ojcc-b	3	0.6	19	3.9	9	1.8	195	39.6	266	54.1	492	100.0
28-U-Ojcc-e	11	3.9	27	9.7	2	0.7	100	35.8	139	49.8	279	100.0
28-U-Ojcc-m			2	1.7	5	4.1	32	26.4	82	67.8	121	100.0
28-U-Ojcc-o							2	50.0	2	50.0	4	100.0
28-U-Ojcc-q	1	100.0									1	100.0
Total	24	1.7	88	6.3	26	1.9	548	39.5	701	50.5	1,387	100.0
Feature 29												
29-01			1	5.6			6	33.3	11	61.1	18	100.0
29-02			3	18.8			4	25.0	9	56.3	16	100.0
29-03	1	50.0					1	50.0			2	100.0
29-04			1	33.3					2	66.7	3	100.0
29-05							2	100.0			2	100.0
29-06							2	100.0			2	100.0
29-07							1	50.0	1	50.0	2	100.0
29-08			1	33.3			2	66.7			3	100.0
29-U-Mbk									2	100.0	2	100.0
29-U-Mch							1	100.0			1	100.0

Table 8.13. Feature Cobbles by Flake Type. (Continued).

	Primary Flake		Secondary Flake		Tertiary Flake		Biface Flake		Flake Fragment		Total	
Cobble[a]	N	%	N	%	N	%	N	%	N	%	N	%
29-U-Ojcc-b			2	15.4			3	23.1	8	61.5	13	100.0
29-U-Ojcc-e	2	7.4	3	11.1			7	25.9	15	55.6	27	100.0
29-U-Ojcc-m			1	5.9			3	17.6	13	76.5	17	100.0
Total	3	2.8	12	11.1			32	29.6	61	56.5	108	100.0
Feature 32												
32-01									2	100.0	2	100.0
32-02	1	50.0	1	50.0							2	100.0
32-03									2	100.0	2	100.0
32-04			3	7.3			16	39.0	22	53.7	41	100.0
32-05			2	100.0							2	100.0
32-U-Mbk									1	100.0	1	100.0
32-U-Ojcc-m	4	28.6	1	7.1			2	14.3	7	50.0	14	100.0
Total	5	7.8	7	10.9			18	28.1	34	53.1	64	100.0
Feature 33												
33-01							3	100.0			3	100.0
33-02							7	46.7	8	53.3	15	100.0
33-03			3	42.9			1	14.3	3	42.9	7	100.0
33-04	1	12.5	1	12.5			5	62.5	1	12.5	8	100.0
33-05	1	50.0	1	50.0							2	100.0
33-06									4	100.0	4	100.0
33-07							7	63.6	4	36.4	11	100.0
33-08							1	50.0	1	50.0	2	100.0
33-U-Mbk							1	33.3	2	66.7	3	100.0
33-U-Mch			1	33.3			2	66.7			3	100.0
33-U-Ojcc-b							1	12.5	7	87.5	8	100.0
33-U-Ojcc-e			1	2.3	1	2.3	14	31.8	28	63.6	44	100.0
33-U-Ojcc-m	1	12.5							7	87.5	8	100.0
Total	3	2.5	7	5.9	1	0.8	42	35.6	65	55.1	118	100.0
Feature 36[b]												
36-01			4	36.4			6	54.5	1	9.1	11	100.0
36-03							1	25.0	3	75.0	4	100.0
36-04							2	50.0	2	50.0	4	100.0
36-05							1	33.3	2	66.7	3	100.0
36-06									2	100.0	2	100.0
36-07									2	100.0	2	100.0
36-08			1	25.0			2	50.0	1	25.0	4	100.0
36-U-Mbk			1	100.0							1	100.0
36-U-Ojcc-e							1	33.3	2	66.7	3	100.0
Total			6	17.6			13	38.2	15	44.1	34	100.0
Feature 38												
29-01									3	100.0	3	100.0
29-04	1	100.0									1	100.0
29-U-Ojcc-e			1	100.0							1	100.0
38-01			1	5.0			6	30.0	13	65.0	20	100.0
38-02	2	18.2	3	27.3			2	18.2	4	36.4	11	100.0
38-03			1	7.7			7	53.8	5	38.5	13	100.0
38-04					1	14.3	3	42.9	3	42.9	7	100.0

Table 8.13. Feature Cobbles by Flake Type. (Continued).

	Primary Flake		Secondary Flake		Tertiary Flake		Biface Flake		Flake Fragment		Total	
Cobble[a]	N	%	N	%	N	%	N	%	N	%	N	%
38-05							1	12.5	7	87.5	8	100.0
38-06									5	100.0	5	100.0
38-07							3	60.0	2	40.0	5	100.0
38-08							1	20.0	4	80.0	5	100.0
38-09							3	75.0	1	25.0	4	100.0
38-10							3	50.0	3	50.0	6	100.0
38-11							2	100.0			2	100.0
38-12							2	100.0			2	100.0
38-13							1	50.0	1	50.0	2	100.0
38-14							2	100.0			2	100.0
38-15									2	100.0	2	100.0
38-U-Ojcc-e			7	7.3			21	21.9	68	70.8	96	100.0
38-U-Ojcc-m	1	50.0							1	50.0	2	100.0
Total	4	2.0	13	6.6	1	0.5	57	28.9	122	61.9	197	100.0
Feature 40												
40-01			9	3.2	4	1.4	92	33.1	173	62.2	278	100.0
Feature 41												
41-01	5	15.2	6	18.2	3	9.1	1	3.0	18	54.5	33	100.0
Feature 42												
42-01	5	9.6	7	13.5	1	1.9	3	5.8	36	69.2	52	100.0
42-02							22	45.8	26	54.2	48	100.0
42-03							15	60.0	10	40.0	25	100.0
Total	5	4.0	7	5.6	1	0.8	40	32.0	72	57.6	125	100.0
Feature 43												
43-01					1	1.7	21	36.2	36	62.1	58	100.0
Feature 44												
44-01	5	7.6	5	7.6	1	1.5	25	37.9	30	45.5	66	100.0
Feature 45												
45-01							3	50.0	3	50.0	6	100.0
45-02							3	60.0	2	40.0	5	100.0
45-03							3	100.0			3	100.0
Total							9	64.3	5	35.7	14	100.0

[a]Undifferentiated items are totaled by their chert type. Codes for chert types are: Mch = Chouteau, Mbk = Burlington, and Ojcc = Jefferson City. The varieties of Ojcc are: e = ellipsoidal, b = banded, m = mottled, o = oolitic, and q = quartzitic.

[b]Cobble 2 in Feature 36 is represented only by a secondary biface.

Figure 8.41. Late Paleoindian knapping Feature 23 (late-stage reduction of four Ellipsoidal Jefferson City chert cobbles) (scale: 1 m).

analyses also resulted in the classification of each lithic feature according to a particular stage or stages in the biface-reduction model (Table 8.14). The biface-reduction model was presented earlier in Chapter 6. Finally, the raw material from each knapping feature is identified as to chert type in Table 8.15. For most features, microdebitage (i.e., flakes <1 cm^2) was excluded from the lithic analyses; however, microflakes were analyzed for a small subsample of features (Features 40, 42, 43, and 44).

Feature 23. This feature consisted of an oval-shaped concentration of debitage that measured approximately 15 x 20 cm in size; it was surrounded by a dispersed scatter of flakes up to 50 x 80 cm (Figure 8.41). It was located in the middle portion of the 3Ab horizon. Maximum thickness was approximately 7 cm. A total of 46 flakes was recovered; they represent five cobbles of Ellipsoidal Jefferson City chert. Based on flake types and size grades, Cobbles 2 and 4 represent early-stage biface reduction, Cobbles 3 and 5 represent middle- to late-stage reduction, and Cobble 1 represents late-stage and/or postmanufacture reduction. The fact that all stages of biface manufacture are represented in the reduction of five separate cobbles indicates that Feature 23 represents multiple episodes of knapping over a period of time, as opposed to a discrete knapping event. Cortical observations indicate that at least four of the five Ellipsoidal Jefferson City chert cobbles were procured from stream contexts.

Feature 24. This feature consisted of an oval-shaped pile of flakes approximately 85 x 130 cm in plan view. It was discovered in the middle portion of the 3Ab horizon with the base of the feature located at 308 cm bs. A total of 116 flakes was recovered; they were knapped from two Ellipsoidal Jefferson City chert cobbles. The majority of flakes belong to Cobble 2 and represent middle- to late-stage biface reduction. Cobble 1, on the other hand, appears to represent early- to middle-stage reduction. Both cobbles were collected from alluvial sources.

Feature 26. Feature 26 consisted of another oval-shaped knapping pile. It measured 40 x 60 cm in plan view and occurred at 298–301 cm bs. The feature comprised a total of 94 flakes in which a minimum of 12 different cobbles is represented. A variety of raw materials (Chouteau chert, Ellipsoidal Jefferson City chert, and Banded Jefferson City chert) and reduction stages are also represented in the debitage. Tools found in association with Feature 26 consist of one polished (adze resharpening) flake and one primary-biface failure that matches the flake debitage of Cobble 1. The small size of the

feature in combination with the large number of cobbles in every stage of biface reduction indicates that Feature 26 represents multiple episodes of knapping over an extended period of time, the debris of which was later collected (swept or dumped) into a small pile. Cortical artifacts reveal that at least six of the Jefferson City chert cobbles were procured from stream deposits, whereas one Chouteau cobble was collected from a residual source and another was obtained from an alluvial source.

Feature 27. This feature consisted of a small (22 cm in diameter) circular pile of debitage found in the upper portion of the 3Ab horizon (293–296 cm bs). Twenty-one flakes, knapped from at least two Ellipsoidal Jefferson City chert cobbles, were recovered. Both cobbles were procured from stream deposits. The size and type of flakes from Cobble 1 indicate early- to middle-stage reduction, whereas Cobble 2 debitage indicates late-stage biface reduction. Two bifaces recovered from TU 15 match the debitage represented in Feature 27. A primary biface recovered at a depth of 297 cm only 10 cm southeast of Feature 27 matches Cobble 1 debitage. Indeed, one flake fragment from Cobble 1 refits onto this biface. Although no refits could be made to firmly establish a connection, a small secondary biface, found at a depth of 297 cm approximately 115 cm south of Feature 27, appears to match Cobble 2 debitage based on visual observations of chert texture, color, and internal structure (mottling).

Feature 28. Feature 28 was an extensive knapping-debris scatter extending over most of TU 21 and into adjacent units TU 4 and TU 22. Only about half of Feature 28 was excavated because the southern portion extended into the south profile wall outside Blocks B and C (Figure 8.40). It measured approximately 3 m in diameter and was at least 11 cm thick (293–304 cm bs). The base of Feature 28 was situated in the middle portion of the 3Ab horizon. A total of 1,387 flakes was recovered from Feature 28, representing a minimum of 46 different cobbles (Table 8.13). A variety of chert types is represented in the debitage: three Burlington cobbles, four Chouteau cobbles, 19 Ellipsoidal Jefferson City cobbles, 15 Banded Jefferson City cobbles, and five Mottled Jefferson City cobbles. A number of undifferentiated flakes of the above types, as well as oolitic and quartzitic varieties of Jefferson City chert, also were recovered from the feature. All stages of biface manufacture and maintenance are represented in the cobble debitage. Nevertheless, the majority appears to represent early- to middle-stage biface reduction. It should be noted, however, that most of the Chouteau debitage reflects late-stage biface reduction, suggesting that for this raw material, most of the cortical surface was removed at the procurement source.

In addition to the large quantity of debitage, a number of preform failures and other tools were recovered from Feature 28: three primary bifaces, seven secondary bifaces, one end scraper, one side scraper, two utilized flakes, and four polished flakes. At least five of the seven secondary bifaces have been visually matched with cobble debitage (Cobbles 1, 9, 10, 11, and 35). In addition to the above artifacts, a complete San Patrice (Hope variety) projectile point appears to have been discarded into the knapping feature. A radiocarbon age of 10,185 ± 75 B.P. (AA-26653) was obtained from a piece of charcoal collected near the middle of Feature 28.

It is clear that this large, dense concentration of debitage represents multiple knapping episodes over an extended period of time. It appears to have been the primary discard pile of the workshop locus in the middle level of the Late Paleoindian horizon. Cortical analyses indicate that chert was procured from both residual and alluvial sources. It appears, however, that there were differences in procurement strategies for the two most common chert types. Of the 13 Ellipsoidal Jefferson City chert cobbles with identifiable cortex, 62% were collected from stream deposits, whereas 57% of the seven Banded Jefferson City chert nodules were procured from residual sources.

In addition to the chipped-stone artifacts, a small grab sample of unmodified manuports was collected from Feature 28. These manuports consist of subangular to subrounded alluvial gravel, of which 10 are pebbles (7.1–67.6 g) and two are cobbles (289.9–319.2 g). All of the pebbles are Burlington chert except for one that is Jefferson City chert. The two cobbles are composed of highly rounded Warner chert; one was utilized as a light-duty hammerstone.

Feature 29. This feature consisted of an oval-shaped concentration of artifacts located on the northwest side of Feature 28. It measured approximately 80 x 110 cm in plan view and was 6 cm thick. It was discovered in the middle portion of the 3Ab horizon partially overlying Feature 38. A total of 108 flakes was recovered in which a minimum of eight separate cobbles was identified. Feature 29 is

Table 8.14. Knapping Features by Reduction Stages.

	Reduction Stage[a]																	
	1		1-2		1-4		2		2-3		2-4		3-4		4		Total	
Feature	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
23			2	40.0					2	40.0			1	20.0			5	100.0
24			1	50.0					1	50.0							2	100.0
26	4	28.6	3	21.4	1	7.1					1	7.1	4	28.6	1	7.1	14	100.0
27			1	50.0									1	50.0			2	100.0
28	6	11.3	10	18.9	2	3.8	25	47.2			7	13.2	3	5.7			53	100.0
29			3	23.1	1	7.7	4	30.8			4	30.8	1	7.7			13	100.0
32	1	14.3	1	14.3	1	14.3	1	14.3			1	14.3	2	28.6			7	100.0
33			1	7.7	2	15.4	4	30.8			3	23.1	3	23.1			13	100.0
36			1	11.1			3	33.3			4	44.4	1	11.1			9	100.0
38			4	25.0	1	5.0	6	30.0			8	40.0					19	100.0
40									1	100.0							1	100.0
41	1	100.0															1	100.0
42			1	33.3					2	66.7							3	100.0
43									1	100.0							1	100.0
44									1	100.0							1	100.0
45							3	100.0									3	100.0
Total	12	8.2	28	19.0	8	5.4	46	31.3	8	5.4	28	19.0	16	10.9	1	0.7	147	100.0

[a]N is the number of cobbles. See Chapter 6 for a description of reduction stages.

Table 8.15. Knapping Feature Lithics by Raw-Material Type.

	Burlington Chert		Chouteau Chert		Banded Jefferson City Chert		Ellipsoidal Jefferson City Chert		Mottled Jefferson City Chert		Oolitic Jefferson City Chert		Quartzitic Jefferson City Chert		Total	
Feature	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
23							46	100.0							46	100.0
24							116	100.0							116	100.0
26			8	8.3	19	19.8	69	71.9							96	100.0
27							21	100.0							21	100.0
28	82	5.8	175	12.4	553	39.3	418	29.7	172	12.2	5	0.4	1	0.1	1,406	100.0
29	2	1.8	1	0.9	49	44.5	41	37.3	17	15.5					110	100.0
32	3	4.7			4	6.3	41	64.1	16	25.0					64	100.0
33	6	5.1	3	2.5	23	19.5	65	55.1	21	17.8					118	100.0
36	5	13.9					31	86.1							36	100.0
38					3	1.5	193	97.5	2	1.0					198	100.0
40			278	100.0											278	100.0
41							34	100.0							34	100.0
42					25	19.8	101	80.2							126	100.0
43							58	100.0							58	100.0
44							66	100.0							66	100.0
45					8	53.3	7	46.7							15	100.0
Total	98	3.5	465	16.7	684	24.5	1,307	46.9	228	8.2	5	0.2	1	<0.1	2,788	100.0

one of only two knapping features in which Banded Jefferson City artifacts outnumber Ellipsoidal Jefferson City artifacts. Five cobbles appear to represent early- to middle-stage reduction and three represent late-stage biface manufacture. In addition to the debitage, one side scraper and one polished (adze resharpening) flake were associated with the feature. Based on the variety of cobbles and manufacturing stages, it appears that Feature 29 represents multiple episodes of biface reduction. Cortical analyses revealed that all three nodules of Banded Jefferson City chert were procured from residual sources, whereas three of the five Ellipsoidal Jefferson City chert cobbles were collected from gravel bars.

Feature 32. This feature consisted of a small, oval-shaped knapping pile measuring approximately 24 x 40 cm. It was found in the middle portion of the 3Ab horizon at a depth of approximately 298–301 cm bs. Sixty-four flakes were collected from Feature 32; a minimum of five cobbles is represented. Of these five cobbles, one is Burlington chert, two are Banded Jefferson City chert, one is Ellipsoidal Jefferson City chert, and one is Mottled Jefferson City chert. Reduction stage is as variable as chert types with early, middle, and late stages represented. This suggests multiple episodes of biface reduction. All of the cortical artifacts from Feature 32 indicate raw-material procurement from alluvial sources.

Feature 33. Feature 33 consisted of another small circular pile of knapping debitage; it measured approximately 38 cm in diameter. It was discovered in the middle portion of the 3Ab horizon (299–306 cm bs) less than 50 cm to the west of Feature 32. A total of 118 flakes was recovered from Feature 33, representing a minimum of eight different cobbles. Burlington, Ellipsoidal Jefferson City, Banded Jefferson City, and Mottled Jefferson City chert types were identified in the debitage, and all stages of biface manufacture are indicated. Most of the cobbles represented in Feature 33 were procured from stream-deposited contexts. Similarities in chert procurement and selection, biface-reduction stages, and feature depths suggests that Features 32 and 33 could be associated with the same workshop activity. In addition to chipped-stone artifacts, seven fire-cracked fragments from a common Burlington chert cobble were found in the feature.

Feature 36. This feature, located in the middle portion of the 3Ab horizon, consisted of a small knapping pile measuring approximately 25 cm in diameter. The northern portion of the feature extended into the north wall of TU 32 and outside Block C. Thirty-four flakes were recovered in which a minimum of seven cobbles is represented. All but one (Burlington) cobble were knapped from Ellipsoidal Jefferson City chert. Most of the cobbles represent middle- to late-stage biface reduction. Three secondary-biface fragments were associated with Feature 36. Two of these are proximal and distal refit fragments that match the debitage from Cobble 1. The proximal and distal ends were found within 10 cm of each other and less than 5 cm apart vertically. The preform failure was a result of end shock, which occurred during the attempted removal of remnant cortex on one side of the secondary biface. The third biface fragment appears to be unrelated to the other artifacts recovered from Feature 36. All cortical artifacts collected from this knapping feature indicate chert procurement from alluvial sources.

Feature 38. Feature 38 consisted of an oblong scatter of knapping debris measuring approximately 75 x 100 cm. It was discovered in the lower portion of the 3Ab horizon (305–310 cm bs) partially beneath Feature 29. Due to the overlapping relationship and proximity of these two features (separated vertically by about 3 cm), a small number of flakes appear to have been mixed during the excavation. For example, five flakes collected from Feature 38 match material recovered from Feature 29.

A total of 197 flakes was collected from Feature 38. These represent a minimum of 15 different cobbles. The knapper(s) responsible for the production of this feature appears to have been highly selective, since all 15 cobbles and all but two undifferentiated chert flakes are Ellipsoidal Jefferson City chert. This contrasts strongly with nearby Features 28 and 29 in which a variety of chert types are represented. The stages of biface manufacture represented in the debitage are also relatively uniform since all but three of the 15 cobbles represent middle- to late-stage reduction. One tertiary-biface fragment was found in association with the feature debitage. The uniform selection of raw material and the relatively uniform stages of reduction suggest that a single knapper or a small number of knappers produced Feature 38. Cortical artifacts indicate that the knapper(s) procured Ellipsoidal Jefferson City chert cobbles from both residual and alluvial sources.

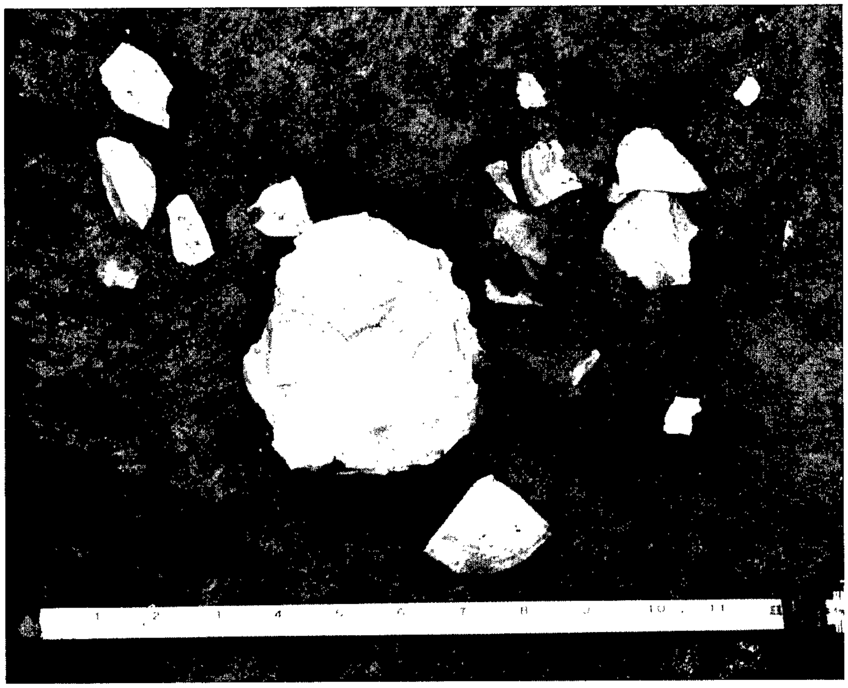


Figure 8.42. Late Paleoindian knapping Feature 41 (early-stage reduction of one Ellipsoidal Jefferson City chert cobble) (scale: 30 cm).

Feature 40. This feature consisted of a small oval-shaped pile of knapping debitage located in the southeast corner of TU 23 and extending into the south wall of Block C. The feature was discovered at the base of and within a cultural (manuported) layer of river gravel in the lower portion of the 3Ab horizon at the shoulder of the T1c (early submember) stream bank that dips steeply along the west side of Block C (Figure 8.18). Although Feature 40 was excavated from the manuport gravel lens, it may predate the lens (see Figure 8.45) and possibly was buried by or incorporated into the lens at the time of gravel deposition. The long axis of Feature 40 measured only 25 cm. Other (nonfeature) artifacts were recovered from the gravel lens up to 80 cm west of Feature 40. In addition, a small unmodified piece of hematite was found 14 cm north of the knapping feature, and a corner-notched Wilson point was recovered at the base of the gravel lens approximately 35 cm west-northwest of Feature 40. The projectile point/knife, however, which was knapped from an unidentified exotic chert, does not appear to be directly associated with the feature.

Feature 40 yielded a total of 278 flakes, all of which appear to have been knapped from a single nodule of Chouteau chert procured from a residual source. Preliminary testing and decortication of the nodule apparently occurred at the procurement site since the sizes and types of flakes in the feature represent middle- to late-stage biface reduction. Based on analyses of the recovered artifacts, it appears that Feature 40 represents a single episode of middle- to late-stage biface manufacture that was conducted on the west edge of the T1c surface. It was subsequently covered by a layer of manuported river gravel.

Feature 41. Feature 41 consisted of a discrete pile of knapping debris located in the northwest corner of TU 33 in Block D (Figure 8.30). It measured approximately 40 x 44 cm in size and was discovered at a depth of 308–312 cm bs in the lower portion of the 3Ab horizon. A total of 33 flakes knapped from a single cobble of Ellipsoidal Jefferson City chert was collected from the feature (Figure 8.42). The flake debitage indicates early-stage biface reduction on a cobble procured from an alluvial source. One large primary biface (560 g) of Ellipsoidal Jefferson City chert was also recovered from the west-central portion of the feature. This primary biface was aborted early during manufacture due to pockets of quartzose (coarse-grained

quartz) in the cobble interior. At least 14 of the 33 flakes refit directly onto the primary biface. Feature 41 represents a single episode of early cobble-blank reduction and subsequent discard.

Feature 42. This feature consisted of an oval-shaped scatter of chert debitage in TU 30 in Block D (Figure 8.30). It measured approximately 20 x 30 cm in size and occurred at a depth of about 305–308 cm bs in the middle portion of the 3Ab horizon. A total of 125 flakes was recovered in which a minimum of three cobbles is represented. Two of the cobbles are Ellipsoidal Jefferson City chert and one cobble is Banded Jefferson City chert. The debitage indicates that Cobble 1 represents early to middle stages of biface reduction, whereas Cobbles 2 and 3 represent middle to late stages of reduction. One secondary biface matches the middle- to late-stage debitage from Cobble 2. Based on the reduction stages present, it appears that at least two separate episodes of biface manufacture are represented in the debitage from Feature 42. Middle- to late-stage reduction of Cobbles 2 and 3 produced no cortical artifacts; however, over 30 cortical flakes detached from Cobble 1 indicate that it was procured from an alluvial source. In addition to the chipped-stone artifacts, one small piece of unmodified hematite was recovered from Feature 42.

Feature 43. This feature (Figure 8.40) was originally thought to be associated with nearby Feature 23 (field assigned Feature 23B); however, it was reassigned as Feature 43 based on varying depths and feature contents. This nearly round (30 x 35 cm) knapping feature was found in the middle portion of the 3Ab horizon at a depth of 303–306 cm bs. Fifty-eight flakes were recovered from the feature, all of which appear to have been knapped from a single Ellipsoidal Jefferson City cobble. Debitage analyses indicate that Feature 43 represents a discrete episode of middle- to late-stage biface reduction of an alluvial cobble. At the conclusion of the biface reduction, the debitage was swept or dumped into a tight waste pile.

Feature 44. Feature 44 consisted of a small circular pile of debitage discovered in TU 27 in the middle portion of the 3Ab horizon at a depth of approximately 304–305 cm. Eighteen small flakes from a common cobble were collected from an area measuring approximately 20 cm in diameter; however, laboratory analysis of debitage from Level 31 revealed an additional 48 flakes from the same cobble. All 66 flakes were knapped from an Ellipsoidal Jefferson City chert cobble procured from an alluvial source. Flake types and sizes indicate middle- to late-stage biface reduction. This feature clearly represents a single episode of middle- to late-stage biface manufacture.

Feature 45. This feature consisted of an artifact concentration discovered in the vertical cutbank approximately 8 m south of the southwest corner of Block B (Figure 8.36). The artifacts were found lying flat at 304–305 cm bs in the middle portion of the 3Ab horizon. The diameter of the exposed portion of the feature was approximately 15 cm. A total of 14 flakes was recovered, representing three different cobbles. Cobble 1 was knapped from Ellipsoidal Jefferson City chert, whereas Cobbles 2 and 3 were knapped from Banded Jefferson City chert. All three cobbles appear to represent the middle stage of biface reduction. One secondary-biface failure, which matches Cobble 1, was also recovered from the feature. No cortical artifacts were found in Feature 45. The uniformity of reduction debitage suggests that three previously decorticated biface preforms were reduced during a relatively short period of time, perhaps during a single setting by one or two knappers.

Cultural Affiliation. Most of the knapping features cannot be directly associated with the Dalton component or the San Patrice component due to the general absence of diagnostic artifacts. The cultural affiliations of a few features have been extrapolated, however, based on potentially diagnostic artifacts such as preforms and hafted end scrapers.

Feature 23 appears to be affiliated with the San Patrice component based on a small oval-shaped preform (Figure 8.33b). Two biface flakes from Feature 23 refit with this small biface, which was found a short distance away (50 cm to the west). Feature 27 also appears to be affiliated with the San Patrice component. One small primary-biface reject (Figure 8.43b) was directly associated with Feature 27 by a refit flake. Although no refits were associated with the other small, round preform (Figure 8.33e), the chert attributes of this secondary biface appear to match Cobble 2 in Feature 27. Both of these bifaces are too small for the production of Dalton points, but well within the range of San Patrice points.

Feature 28 appears to be affiliated with both Late Paleoindian components. A San Patrice connection was demonstrated by the recovery of a complete Hope variety dart point (Figure 8.35a) near the middle of this large knapping feature. Although no Dalton points were associated with Fea-

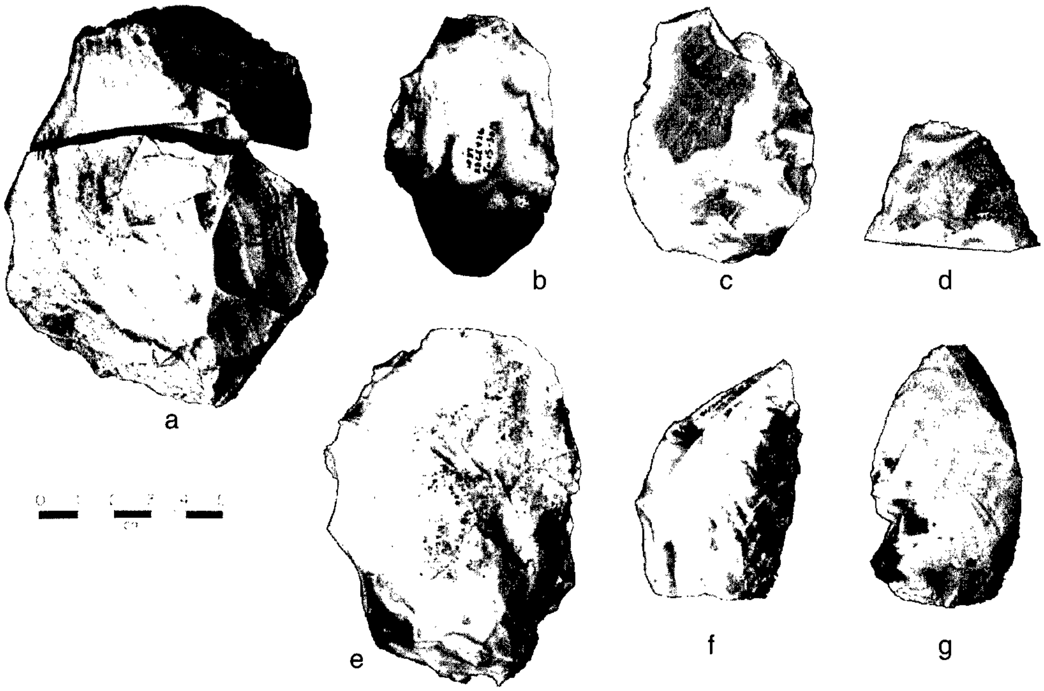


Figure 8.43. Late Paleoindian bifaces: (a-b, e) primary bifaces; (c-d, f-g) secondary bifaces.

ture 28, multiple tools probably manufactured by Dalton knappers were also found in this feature: one large preform with a squared base (Figure 8.33g) that refits with a flake from Cobble 20; another very large distal end fragment (Figure 8.27c) found in the feature debitage; and one large hafted end scraper (Figure 8.25i), two fragments of which were found in Feature 28. In addition, four polished adze flakes found in Feature 28 are probably associated with Dalton activities.

Feature 29 may be affiliated with the Dalton component based on the recovery of a fragment of a refitted spurred end scraper with an elongated haft element (Figure 8.25h). The proximal end of this refitted scraper was found in Feature 29, and the distal end was recovered a short distance to the south beneath Feature 28. Feature 45 also appears to be associated with the Dalton component. This feature contained a large proximal preform fragment with a squared base (Figure 8.27d) similar to other Dalton preforms.

Gravel Features

Also encountered in Blocks B and C were several curious piles of unsorted alluvial gravel. The gravel piles were not uncommon in the 3Ab horizon (n=9) and were usually found scattered about and occasionally mixed with some of the knapping features. When these gravel piles were first encountered, they were believed to be natural in origin (e.g., overbank gravel-splay deposits). Although the general configuration of each gravel feature was mapped, most were not consistently treated as cultural features. Excavation of these gravel piles was relatively rapid, and little of the contents other than an occasional flake or tool fragment was collected.

As excavations in Blocks B and C progressed, however, it became evident that these gravel piles were probably cultural in origin. Two gravel piles were assigned feature numbers, and one of these was collected and analyzed in detail.

Table 8.16. Sizes and Weights of Feature 25B Gravels.

Specimen Number	Maximum Dimension (cm)[a]	Weight (g)	Specimen Number	Maximum Dimension (cm)	Weight (g)
1	0.80	0.17	21	2.65	7.06
2	0.83	0.10	22	2.18	5.84
3	0.96	0.54	23	2.92	3.06
4	1.38	0.63	24	2.52	7.10
5	1.38	0.70	25	2.47	5.12
6	1.73	1.03	26	2.37	6.19
7	1.95	2.03	27	3.58	9.39
8	2.02	2.54	28	3.30	9.25
9	1.93	3.28	29	3.20	16.53
10	1.73	1.78	30	3.29	25.51
11	2.43	1.86	31	4.45	21.84
12	2.62	1.76	32	4.01	21.93
13	2.66	2.48	33	4.59	27.94
14	2.44	2.47	34	4.54	41.04
15	2.04	3.56	35	4.82	45.87
16	2.09	4.47	36	5.56	50.92
17	2.35	3.40	37	5.81	46.33
18	2.17	5.10	38	5.50	64.60
19	3.00	3.18	39	6.87	89.71
20	2.38	4.19	40	6.96	58.26

[a] Pebbles = 0.4–6.4 cm; cobbles = 6.4–25.6 cm.

Feature 25. This gravel feature consisted of two concentrations located along the east side of Block B (Figure 8.40). The larger concentration, designated Area A, consisted of a loosely scattered pile of alluvial gravel found in the middle portion of the 3Ab horizon (298–308 cm bs) in TU 16 and TU 17. Area A was composed of unsorted pebbles and cobbles that extended over an area of approximately 50 x 135 cm. Three artifacts scattered among the gravel included one primary biface and two flakes knapped from exotic raw material (Pitkin and Red Pierson cherts). Area B consisted of a smaller (35 x 40 cm) and tighter cluster of gravel located in the upper portion of the 3Ab horizon (292–297 cm bs) approximately 90–135 cm to the north of Area A. It exhibited an irregular shape and contained only one artifact, a tested cobble. Based on differing depths and configurations, it appears that Areas A and B are probably unrelated.

Feature 25B was collected and later analyzed in the laboratory. All of the gravel is subangular to subrounded in shape (characteristic of Sac River gravels) and all appear to be Burlington chert except for one pebble of Warner sandstone. Each piece of gravel was weighed and the long axis was measured (Table 8.16). Of the 40 pieces of gravel collected, 38 are pebbles (0.4–6.4 cm) and two are cobbles (6.4–25.6 cm). The data indicate that Feature 25B represents an unsorted collection of fine to coarse alluvial gravel, which is similar to what might be expected if a basket load of gravel was collected from the Sac River.

Feature 37. This gravel feature consisted of a large, amorphous-shaped concentration of alluvial gravel with a sparse scatter of artifacts located in the northern portion of Block C (Figure 8.40). It was discovered in the lower portion of the 3Ab horizon. The entire gravel feature was not excavated since the northern portion extended outside the block excavation. Three tested cobbles and at least six flakes were found associated with the feature.

Discussion. At least six other distinct gravel piles were noted during the excavation of the Late Paleoindian levels in Blocks B and C (Figure 8.40).

Figure 8.44. Profile of small Late Paleoindian manuported gravel pile feature in cutbank. Trowels point to in situ artifacts (scale: 1 m).

They were highly variable in size and shape, occurring in small, circular clusters (Figure 8.44) less than 20 cm in diameter to large, amorphous-shaped deposits (Figure 8.45) covering at least 2.5 m^2. These gravel piles appear to be cultural in origin for several reasons. First, most contain a light scatter of artifacts that exhibit no evidence of fluvial transportation such as edge rounding and patination. Most of the artifacts within these gravel piles are the same types (i.e., workshop debitage) found in the knapping features, such as waste flakes, tested cobbles, and an occasional biface fragment. Second, at least one knapping feature was encompassed by a large gravel pile. This feature (Feature 40) consisted of a small, concentrated pile of 278 flakes knapped from Chouteau chert, a lithic resource rarely found in Sac River gravels. Third, the undisturbed condition of the knapping features found within and interspersed among the gravel piles argues against fluvial deposition. Fourth, the gravel piles were often arranged in unnatural circular or irregular patterns, and they tend to exhibit a mounded profile with a flat base as if dumped or arranged on a living surface.

None of these characteristics typify natural gravel lenses or splay deposits. It appears, therefore, that they are manuported gravel piles, although their intended function is unclear. They appear to be arranged in a random fashion with no discernible pattern. They do not appear to be raw-material (knapping) cache piles because the inclusive gravels are invariably fluvially unsorted, i.e., the gravel occurs in mixed sizes, ranging from small pea size to cobbles. It is unlikely that such large quantities of alluvial gravel were transported onto the site for lithic-reduction purposes when only 5% are knappable size (Table 8.16). Raw-material caching would involve selection for predominantly cobble-sized material. Furthermore, the vast majority of the alluvial gravel is composed of Burlington chert, not the ellipsoidal cobbles of Jefferson City chert or Chouteau chert that Late Paleoindian knappers preferred (see Chapter 9). Some of the cobbles in the manuport piles were tested and at least one was used as a hammerstone, but these few utilized cobbles appear to represent an opportunistic reduction activity rather than an intentional raw-material procurement strategy. It is possible that the gravel piles had no intended purpose, but instead represent random play activities of juveniles in the lithic-workshop area. In any regard, the only general conclusions that can be offered at this time is that they represent manuport activity and they are associated with the Late Paleoindian occupation. More specific conclusions about these peculiar gravel piles must await future excavations in

Figure 8.45. Plan view of large Late Paleoindian manuported gravel pile feature in southwest corner of Block C (TU-23) at 316 cm below surface. Trowel points to in situ artifacts at the top of Feature 40 (scale: 30 cm).

the 3Ab horizon with more detailed recovery methods and analyses.

There apparently is at least one other site in the Ozarks containing similar gravel features in an early prehistoric context. At the Two Rivers site (23SH101), three large gravel features were discovered and described as mounded gravel situated on and just above a natural graveliferous substratum (Klinger et al. 1989:69–71). Although the features were not completely excavated, they were large in size and appeared to be circular (> 1 m in diameter) or linear (3.75 m) in shape. Except for the extensive bed of gravel found in the southwest corner of Block C (Figures 8.18 and 8.19), most of the gravel features at the Big Eddy site were much smaller in size and none approached the thickness of the gravel piles at Two Rivers (up to 70 cm thick). Evidence supporting a cultural origin for the Two Rivers gravel features included unnatural steep profiles of the gravel piles, a silt-loam gravel matrix unlike the natural gravel substrate, and a light scatter of artifacts mixed within the gravel features (Klinger et al. 1989:71). The precise function and age of these features were impossible to determine, although it was suggested that the gravel piles may have served as a primitive windbreak, and that they were probably associated with the Paleoindian (i.e., Clovis and/or Dalton) occupations (Klinger et al. 1989:71, 85–86).

Refit Analysis

The rather distinctive varieties of raw material represented in the artifacts and the large volume of workshop debitage and numerous preform failures recovered from the Late Paleoindian 3Ab horizon provided a good opportunity for a refit analysis. A primary goal of the refit study was to evaluate vertical and horizontal displacement of Late Paleoindian artifacts, especially the degree of vertical movement, which might indicate displacement vs. relatively undisturbed living surfaces. Preliminary

refits were made by the author during artifact and chert analyses; however, most were made by Kary Stackelbeck during a detailed refit analysis of Early/Middle Paleoindian and Late Paleoindian materials. This detailed study of all refitted artifacts is in progress and will be reported in an M.A. thesis (Stackelbeck 1998).

Fifteen refit examples are discussed below (Table 8.17). All but one (Refit "o" in Block D) are located in Blocks B-C (Figure 8.46). Refit examples are of two types: eight refits (representing 20 separate pieces) are tool-fragment-to-tool-fragment matches (Refits "a" through "h"), and seven examples represent refits between knapping-feature flake debitage and isolated bifaces (Refits "i" through "o"). The majority of the 15 refit specimens were piece-plotted in the field and are represented by enclosed (solid) circles in Figure 8.46. In a few examples, one or two pieces of a refit were not identified as tool fragments in the field and have only generalized test-unit and level proveniences. The horizontal proveniences of these specimens, therefore, have been extrapolated, and they are depicted as open circles in Figure 8.46. At least five additional biface-fragment-to-biface-fragment refits were identified in Blocks B-C, but they are not presented due to insufficient provenience data. Three of the five, however, have enough provenience information to determine that the refitted items were found in the same test unit and level.

Refit "a" consists of four fragments of a secondary biface, a probable Dalton preform (Figure 8.33k), knapped from Burlington chert. Distal and midsection fragments of this preform were discovered in the western portion of TU 21 at depths of 304 and 308 cm bs, and the proximal end was found near the east edge of TU 22 at a depth of 306 cm bs. A fourth small midsection fragment, which was not identified in the field, was also found in Level 31 (300–310 cm bs) of TU 22. A fifth small midsection fragment was not recovered. At least three piece-plotted fragments of this preform were found within 4 cm vertically and 30 cm horizontally of one another. In addition to the four biface refits, one small biface flake from Level 31 (300–310 cm bs) of TU 21 refitted onto a midsection fragment. It is difficult to determine how this preform broke into multiple fragments, but it is clear that it was not broadcast across the ground surface subsequent to breakage. Although two fragments of the secondary biface were found just beneath knapping Feature 28, Refit "a" appears to be unassociated with this large knapping feature. None of the Burlington chert flakes found in Feature 28 conjoin or visually match Refit "a" raw material.

Refit "b" consists of the proximal and distal portions of a spurred end scraper (Figure 8.25h). It broke along a weak incipient fracture plane during use. The distal (bit) end was recovered from the southwest portion of TU 21 at a depth of 305 cm bs, which appears to be just beneath the base of Feature 28. The proximal (hafted) end was found in Feature 29, which occurred at 301–307 cm bs. Although the proximal end was not piece plotted, the minimum and maximum horizontal distances between the scraper fragments are approximately 60 and 160 cm.

Refit "c" consists of two fragments of an end scraper (Figure 8.25i). A third small fragment is missing. The larger fragment was found within the massive debris pile of Feature 28 (293–304 cm bs), whereas a small corner bit fragment was recovered from the southwest corner of TU 4 within Level 29 (also in Feature 28). This end scraper appears to have broken as a result of thermal shock.

The most surprising example is Refit "d," which consists of a failed, large secondary biface with multiple fragments, three of which were recovered (Figure 8.46). Unfortunately, none of the three refit fragments was piece plotted in the field. One small edge fragment, which was not recognized as part of a biface during excavation, was collected from Level 30 (290–300 cm bs) in TU 12. A second specimen, a midsection fragment, was recovered from Level 30 (290–300 cm bs) of TU 4, the adjacent unit to the south. It exhibits several potlids and other fractures indicative of thermal shock. The smaller edge fragment refits onto this midsection fragment. Although it is unclear due to the thermally fragmented nature of the larger piece, it appears that the smaller edge fragment represents a minor overshot failure produced early in the reduction sequence. The third refit specimen, another midsection fragment, was recovered from cutbank slumpage. It refit to the midsection fragment found in TU 4; the minimum horizontal distance between the pieces is 8.5 m. At least one lateral edge of the third fragment was slightly trimmed subsequent to failure and then it too was rejected. Based on the apparent proximity of fragments one and two and the remarkable distance between the two midsection fragments (two and three), it appears that the third specimen may represent a fragment that was briefly modified and then tossed to the south.

Table 8.17. Late Paleoindian Tool Refits.

Refit Specimen	Location	Minimum-Maximum Horizontal Separation (cm)	Depth (cm)	≤5-cm Vertical Separation
Refit a				
Secondary biface, distal	TU-21	30	304	Yes
Secondary biface, midsection	TU-21	30	308	Yes
Secondary biface, proximal	TU-22	30	306	Yes
Secondary biface, midsection	TU-22	Uncertain	300–310	Uncertain
Refit b				
End scraper, distal	TU-21	60–160	305	Yes
End scraper, proximal	F-29	60–160	301–307	Yes
Refit c				
End scraper, proximal	F-28	5–300	293–304	Uncertain
End scraper, distal	TU-4	5–300	280–290	Uncertain
Refit d				
Secondary biface, fragment	TU-12	5–395	290–300	Uncertain
Secondary biface, midsection	TU-4	850	290–300	Uncertain
Secondary biface, midsection	Cutbank	850		Uncertain
Refit e				
Drill, proximal	TU-26	246	297	Yes
Drill, midsection	TU-27	246	302	Yes
Refit f				
Tertiary biface, distal	TU-25	40–240	305	Yes
Tertiary biface, midsection	TU-26	40–240	300–310	Yes
Refit g				
Secondary biface, distal	TU-27	5–195	295	Yes
Secondary biface, proximal	TU-27	5–195	290–300	Yes
Secondary biface, midsection	TU-27	5–195	290–300	Yes
Refit h				
Secondary biface, distal	F-36	12	303	Yes
Secondary biface, proximal	F-36	12	308	Yes
Refit i				
Primary biface	TU-15	10–32	295–297	Yes
Feature 27	TU-15	10–32	293–296	Yes
Refit j				
Secondary biface	TU-13	35–75	292	No
Feature 26	TU-13	35–75	298–301	No
Refit k				
Primary biface	TU-13	125–145	304	Yes
Feature 44	TU-27	125–145	304–305	Yes
Refit l				
Primary biface	TU-25	5–80	310	Yes
Feature 38	TU-25/26	5–80	310–315	Yes
Refit m				
Secondary biface	TU-4	100–350	291	Uncertain
Feature 28	TU-4/21/22	100–350	293–304	Uncertain
Refit n				
Secondary biface	TU-8	50–120	296–303	Yes
Feature 23	TU-8	50–120	295–302	Yes
Refit o				
Primary biface	TU-33	1–20	310	Yes
Feature 41	TU-33	1–20	308–312	Yes

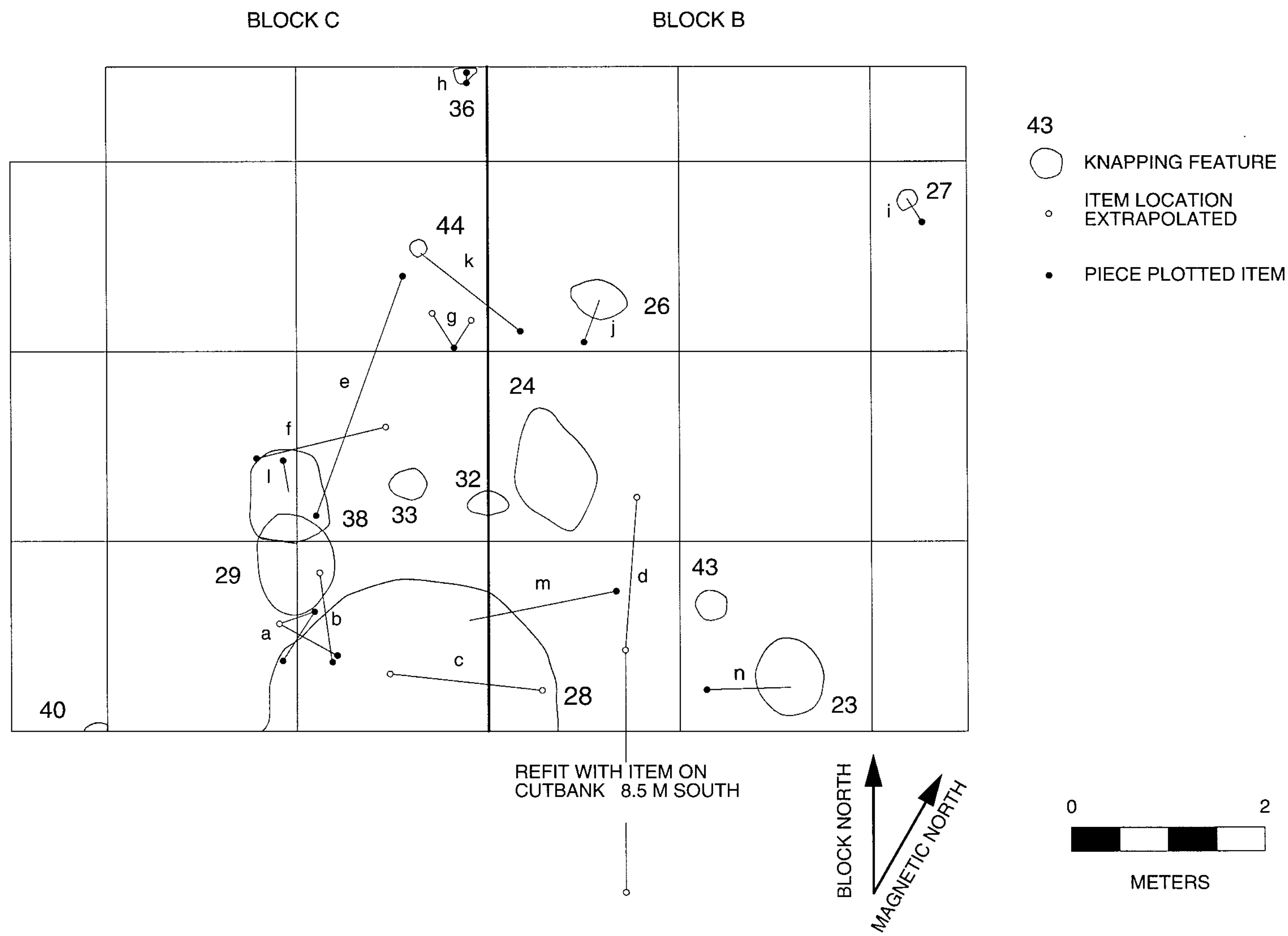


Figure 8.46. Late Paleoindian refit artifacts and knapping features (majority of refit data provided by Kary Stackelbeck).

Refit "e" consists of two fragments of a finished drill (Figure 8.25o) that was broken during use. The bulbous-shaped proximal or basal fragment was discovered in the southwest corner of TU 26 at a depth of 297 cm bs (above Feature 38). A midsection portion of the bit was subsequently found 2.46 m to the northeast in TU 27 at a depth of 302 cm bs. The distal end of the bit was not recovered. This broken drill represents the second longest horizontal distance of a refitted specimen identified in the Late Paleoindian deposits and the longest distance of a finished tool (i.e., broken during use rather than manufacture).

Refit "f" consists of two pieces of a bevelled tertiary-biface fragment (Figure 8.27b) that probably represent the medial and distal portions of a broken (finished) Dalton point. The large distal fragment was discovered in the southeast quadrant of TU 25 at a depth of 305 cm, at least 5 cm above knapping Feature 38. Although the much smaller midsection fragment was not piece plotted in the field, it was recovered from TU 26 at a minimum distance of 40 cm to the east. It also occurred in Level 31 (300–310 cm).

Refit "g" consists of three fragments of a small secondary biface that exhibits multiple thermal fractures (Figure 8.32j). The largest fragment was found in the southeast corner of TU 27 at a depth of 295 cm bs. Unfortunately, the other two small fragments were not identified as biface fragments in the field and were not piece plotted. Both fragments, however, were also recovered from Level 30 (290–300 cm) in TU 27. Although identification is complicated by subsequent thermal fracture scars, the transverse fracture exhibits a lipped appearance indicative of a break produced by lateral or end shock. It appears, therefore, that this small biface failed during lateral or basal thinning and was subsequently exposed to a source of intense heat.

Refit "h" consists of two fragments of a failed secondary biface that was associated with knapping Feature 36. The distal end was discovered in the northeast corner of TU 32 at a depth of approximately 303 cm bs; the proximal end was subsequently found only 12 cm to the north at a depth of 308 cm bs. This secondary biface was broken by a blow to the left basal margin (Figure 8.32a), which resulted in end-shock failure.

Refit "i" consists of a primary biface found in the northern portion of TU 15 at a depth of 293–297 cm bs and a flake fragment. The flake fragment was recovered from Feature 27 (Cobble 1); it refits on the outer edge of the primary biface. The primary biface was situated only 10 cm from the southeast edge of Feature 27 (located 293–296 cm bs). After preliminary decortication, this whole primary biface (Figure 8.43b) possibly was rejected due to its small size.

Refit "j" consists of a secondary biface that was recovered near the southern edge of TU 13 and a flake. The biface (Figure 8.43c) was found in an apparently disturbed, vertical position with a center point of approximately 292 cm bs. One secondary flake from Cobble 3 of Feature 26 (298–301 cm bs) refit with the edge of the biface. The horizontal distance between Feature 26 and the secondary biface is approximately 35 cm. This secondary biface exhibits multiple, but relatively minor, fractures at the distal end. These fractures, its small size, and the presence of a prominent incipient fracture plane across the middle apparently caused the rejection of this biface.

Refit "k" consists of a primary-biface fragment (Figure 8.43d) recovered from the southwest corner of TU 13 at a depth of approximately 304 cm bs and two flakes. One primary flake and one flake fragment recovered from Feature 44 (304–305 cm bs) refit on one side of the biface. The biface was located about 125 cm to the southeast of Feature 44. A transverse fracture that occurred during cortex removal caused the rejection of this primary biface.

Refit "l" consists of a large primary biface (Figure 8.43e) that was found on top of the northern end of Feature 38 at a depth of 310 cm bs and two flakes. Feature 38 was excavated and recorded at a depth of 310–315 cm bs. Two biface (thinning) flakes recovered from Feature 38 refit on opposite sides of the biface. This large, whole primary biface was abandoned due to a coarse inclusion (patchy quartzose) near the middle of the Ellipsoidal Jefferson City chert cobble.

Refit "m" consists of a large secondary-biface failure recovered from the northeast corner of TU 4 at a depth of 291 cm bs and a flake fragment from Feature 28 (Cobble 20). The biface was found at a minimum distance of 100 cm from the eastern edge of Feature 28 (293–304 cm bs). The secondary biface, a probable Dalton preform (Figure 8.43f), was rejected immediately after a diagonal break occurred during lateral or basal thinning.

Refit "n" consists of a secondary biface found in the southwest corner of TU 8 at a depth of 296–303 cm bs and two biface flakes from Feature 23 (295–302 cm bs) that refit to opposite sides of the bi-

face. The biface was recovered approximately 50 cm west of the western edge of Feature 23. It is intact except for a small fragment missing from one corner of the proximal end (Figure 8.43g). The creation of this fragment, which detached along an incipient fracture plane during biface thinning, was apparently enough to cause its rejection. Based on size, this aborted biface may represent a San Patrice preform.

The last and perhaps best example of refitting (Refit "o") was found in Feature 41 located in Block D (Figures 8.31c and 8.42). This feature represents a single episode of initial biface reduction. It consists of 33 waste flakes and a large primary biface that exhibits partial decortication on both sides of an alluvial Jefferson City chert cobble. All of the debitage from Feature 41 was found at 308–312 cm bs. Of the 33 flakes recovered from the feature, 14 (42%) have been successfully refitted onto the primary biface. The refitted debitage consists of three primary flakes, three secondary flakes, two tertiary flakes, one biface flake, and five flake fragments. A coarse impurity (quartzose) in the cobble interior caused the rejection of the biface during the primary stage of reduction.

Radiocarbon Ages

Six radiocarbon dates were obtained from the Late Paleoindian 3Ab horizon of the early submember (see Table 7.1). A seventh sample (AA-27488) is from the transitional zone at the base of the Late Paleoindian horizon. Five of these are AMS samples taken from piece-plotted locations and two are bulk carbon samples taken from sections 10 cm thick. Most of the dates correspond with the generally accepted radiocarbon age range of Late Paleoindian (Goodyear 1982). Only one bulk carbon date (Tx-9329) from 290–300 cm bs is younger than this accepted age range (see Chapter 7).

The vertical difference between the oldest (10,470 B.P. ± 80 at 321 cm bs: AA-27488:) and youngest (10,185 B.P. ± 75 at 298 cm bs: AA-26653) samples from the youngest increments of the early submember is 23 cm. Since the difference in the dates is 285 years, this yields an average sediment accumulation of 0.8 mm/year. Based on this rate of sedimentation, an extrapolated age for stabilization of the T1c surface at 285 cm bs is approximately 10,020 B.P. Since Dalton points were found at the base and the top of the 3Ab horizon, it appears that Dalton peoples occupied the early submember floodplain intermittently over a span of approximately 450 years, from about 10,470 to 10,020 B.P.

The earliest dates from Rodgers Shelter (10,200 ± 330 and 10,530 ± 650), reported to be associated with the oldest dated Dalton assemblage in eastern North America (Kay 1982e:544), are roughly equivalent to the Big Eddy dates. The Big Eddy radiometric ages, however, have much smaller standard deviations and, therefore, are more accurate measures of Dalton occupations in southwest Missouri. Except for the earliest date from the lowest level of Graham Cave (9800 B.P. ± 500 B.P.), other dates from sheltered sites (Graham Cave, Arnold Research Cave, Modoc Rockshelter) that have been associated with Dalton points (Chapman 1975:236) are several centuries younger than the Big Eddy dates. As O'Brien and Wood (1998:76) point out, this may be due to the mixing of older and younger deposits in sheltered sites. Unfortunately, only one radiocarbon date (9800 B.P) was obtained from the Montgomery site (Collins et al. 1983:28–29), and it was of questionable cultural affiliation. This sample, taken from "a large fragment of a...tree trunk or branch" 1.5 m below the horizon identified as Dalton, may actually date a tree burn.

Summary and Conclusion

Excavations in the 3Ab horizon yielded a wealth of data on the Late Paleoindian occupation of the Big Eddy site. The high integrity of the cultural deposits and unusual quantity of artifacts recovered presented a rare opportunity to interpret site structure, spatial organization, and technological aspects of the Late Paleoindian manifestation.

Site Structure

The Late Paleoindian deposits are confined to the 3Ab horizon at the top of the early submember at approximately 290–320 cm bs. In profile, this dark-colored horizon (10YR 3/3) is clearly differentiated from the lighter-colored (10YR 4/4) overlying and underlying deposits. The dark color is at least partially, if not primarily, due to organic enrichment by intense or frequent human occupation. The 3Ab horizon in Block D, located only 20 m to the north, is lighter than it is in Blocks B and C. In Core 5, the 3Ab horizon is even lighter than it is in Block D.

The youngest stratum of the early submember was accumulating rapidly enough to bury and pre-

serve discrete features and living surfaces. Based on the suite of six radiocarbon dates (see Table 7.1), the 35 cm represented in the 3Ab horizon was deposited in a span of approximately 450 years (ca. 10,470–10,020 B.P.), an rate of approximately 0.8 mm/year. Of course, it is more likely that aggradation was punctuated, possibly with relatively thick lenses of silt laid down during large floods. The aggradation rate of the lower [early] Rodgers Shelter alluvium (11,000–8000 B.P.) at the Rodgers Shelter site (McMillan 1976a:213) was calculated to be about twice that of the early submember at the Big Eddy site, 1.8 mm/year vs. 0.8 mm/year.

The early submember floodplain (in the vicinity of Blocks B-C) during late Pleistocene times was apparently a local topographic high in the Sac River valley, which was probably one of the important factors contributing to its selection as a Late Paleoindian workshop and residential site. Dipping scarps are evident in profile on either side of Blocks B and C (Figure 8.36). Similar topographic highs appear to have been located approximately 25 m west of Blocks B-C as well as approximately 60 m east of Blocks B-C. The nature and extent of these buried landforms and inclusive prehistoric deposits, however, are unknown since these areas were not investigated during the 1997 excavations.

Although apparently situated on a topographic high in the Sac River floodplain, the earliest known inhabitants (Early Paleoindian to Early Archaic) were nevertheless probably subjected to frequent flooding during late Pleistocene and early Holocene times. This is evident in the rapid rate of silt deposition and artifact burial during these times. Unless the channel of the Sac River at the end of the last glaciation was significantly lower than it is today, the Paleoindian and Early Archaic living surfaces, lying only about 1.8–3.7 m above present base flow, were quite vulnerable to flooding. Risk of flooding in southwest Missouri is greatest during late winter, spring, and early summer. Although there is a general lack of botanical and faunal data, it appears that the Late Paleoindian and Early Archaic occupations are associated with periods of nonflooding (i.e., late summer to fall). This correlates with proposed settlement models of early autumn lowland aggregation versus winter upland dispersal of late Pleistocene–early Holocene hunter-gatherers (Chapman 1977; Walthall and Holley 1997).

At least two Late Paleoindian components are represented in the 3Ab horizon at the top of the early submember: Dalton and San Patrice (Ray et al. 1998). The tentatively defined Wilson point may represent a third Late Paleoindian component. Although impossible to discern visually in profile, there appears to be some stratification of the 3Ab horizon based on general debitage densities (Figures 8.22 and 8.23) and the location of lithic features in the lower, middle, and upper sections (Table 8.10). Debitage and feature densities indicate that the most intensive Late Paleoindian (workshop) activity occurred in the middle and upper portions of the 3Ab horizon at approximately 294–308 cm bs. Although only a few Late Paleoindian projectile points were found in the 3Ab horizon, the recovery of those points and several potentially diagnostic tools and preforms suggests the following cultural stratification.

The Dalton component appears to be represented throughout the 3Ab horizon. For example, two Dalton points were found at the lower and upper boundaries of the 3Ab horizon, and four (refitted) fragments of a shattered Dalton preform (Figure 8.33k) and two refitted fragments of a bevelled tertiary (probable Dalton) biface (Figure 8.27b) were all recovered from Level 31, located in the middle of the 3Ab horizon. In addition, of seven probable Dalton preform failures (Figures 8.27c-d, 8.33g-j, and see Figure 9.3i), one was recovered from Level 29, two were found in Level 30, two were recovered from Level 31, and two were found in Level 32. Finally, three knapping features tentatively affiliated with the Dalton component are all located in the middle portion of the 3Ab horizon.

The San Patrice component, on the other hand, appears to be more restricted. San Patrice artifacts were found in the middle and upper portions of the 3Ab horizon with an apparent concentration in the upper section. For example, all three small dart points (Figure 8.35a-c) and all five probable San Patrice preforms (Figure 8.33a-e) were recovered from Level 30 (290–300 cm bs). The two probable San Patrice refitted drill fragments (Figure 8.25o) were found at 297 and 302 cm bs. In addition, of three knapping features tentatively affiliated with the San Patrice component, two were found in the middle portion of the 3Ab horizon and one was found in the upper portion.

The position of the possible Wilson component, represented by a single projectile point/knife, cannot be accurately determined. The Wilson point (Figure 8.35d) occurred in a particularly deep level within the 3Ab (322 cm bs) because it was found on

the shoulder slope of the T1c stream bank; however, an extrapolation of this landscape position would place it near the middle of the 3Ab horizon.

Several occupational surfaces are probably located in the 30–35-cm-thick Late Paleoindian 3Ab horizon, which spans approximately 450 years. The identification of actual habitation and/or workshop floors in the rapidly aggrading 3Ab, however, is difficult. Workshop activity may have been limited on some surfaces and other surfaces may have been ephemeral due to rapid burial. The spatial distributions of finished tools and production (preform) failures in Blocks B-C are presented in Figure 8.47. This figure represents a compilation of bifacial artifacts found throughout the 3Ab horizon. Except for a slight concentration around the largest knapping feature (Feature 28), the tools and production failures are distributed relatively evenly across the level portion of the T1c surface (i.e., east of the T1c stream bank). The apparent void of bifacial artifacts and lithic features in the central portion of Block B is partially due to the incomplete excavation of the 3Ab horizon in that location prior to digging an exploratory trench to basal gravel. It also should be noted that only those production failures recognized during hand excavation and piece plotted (n=61) are presented in Figure 8.47. An additional 30 production failures were found in association with the workshop area. These include several small fragmentary bifaces identified in the laboratory during detailed artifact analyses and several preforms found eroding from the 3Ab horizon on the cutbank immediately south of Blocks B-C.

Based on artifact concentrations and lithic features, one or more habitation/workshop surfaces were probably located in the middle to upper portion of the 3Ab horizon between 294 and 308 cm bs. Debitage density was greatest in Level 30 (Figures 8.22 and 8.23), and nearly half (45.8%) of the production failures from Blocks B-D were piece-plotted between 294 and 300 cm bs (Table 8.18). The majority of finished tools and knapping features, however, were located slightly lower in the 3Ab horizon. Nearly half (45.5%) of the finished tools were piece plotted between 302 and 305 cm bs (Table 8.18), and half of the knapping features (i.e., the bottom edge or ending depth of features) occurred between 305 and 308 cm bs (Table 8.10). It should be noted that the depths of the lithic features in Table 8.10 are less precise than those for the piece-plotted artifacts. For example, the top few centimeters of lithic features may have been truncated by shovel skimming prior to feature recognition, and the features may have been excavated a few centimeters deeper than the actual base to ensure full feature recovery. The actual upper and lower depths of the knapping features, therefore, may be slightly higher than those recorded in the field. The recovery of several preform failures between 309 and 312 cm bs may indicate another, earlier habitation/workshop surface. If the inference that San Patrice occupations are limited to the middle and upper portions of the 3Ab horizon is correct, then this possible lower living surface is associated with the Dalton component (at least one production failure from this lower level is a Dalton preform). At least two Dalton living floors were identified at Rodgers Shelter based on features encountered in terrace alluvium (Kay 1982a:569).

It is clear that the portion of the Big Eddy site penetrated by Blocks B-D was utilized repeatedly as a lithic-workshop area by Late Paleoindian knappers over a considerable period of time (about 450 years). This appears to reflect long-term continuity in site structure and site function. This, in turn, suggests long-term continuity in the cultural affiliation of the site's occupants. If we assume that the Dalton component represents the local expression of Late Paleoindian, then local Dalton knappers are most likely responsible for establishing and managing the workshop locale during most of the Late Paleoindian period.

The density of lithic artifacts in the 3Ab horizon indicates a workshop midden. The 30-cm-thick 3Ab horizon produced over 10,100 artifacts, nearly three-quarters of which were distributed in a general sheet midden. The remainder were concentrated in 16 discrete knapping piles. The average density of shovel-skimmed artifacts in Blocks B-C varied from a low of 212 per m^3 in the lower portion of the 3Ab horizon to a high of 538 per m^3 in the upper portion (Table 8.19). Certain portions of Blocks B-C, however, exhibited much higher artifact densities, with the highest (TU 21, Level 30) containing 1,614 artifacts per m^3. Screened samples (Table 8.20), of course, produced even larger artifact densities (highest: 4,535 artifacts per m^3 in TU 4, Level 30 with a total of 1,746 per m^3 for Levels 30–32). The primary use of Blocks B-C as a workshop area is also illustrated in a comparison of finished tools (projectile points, scrapers, and drills) to production failures (primary and secondary bifaces). The ratio of finished tools (n=13) to preform failures (n=48) in Blocks B-C is 1:3.7. In other words, pro-

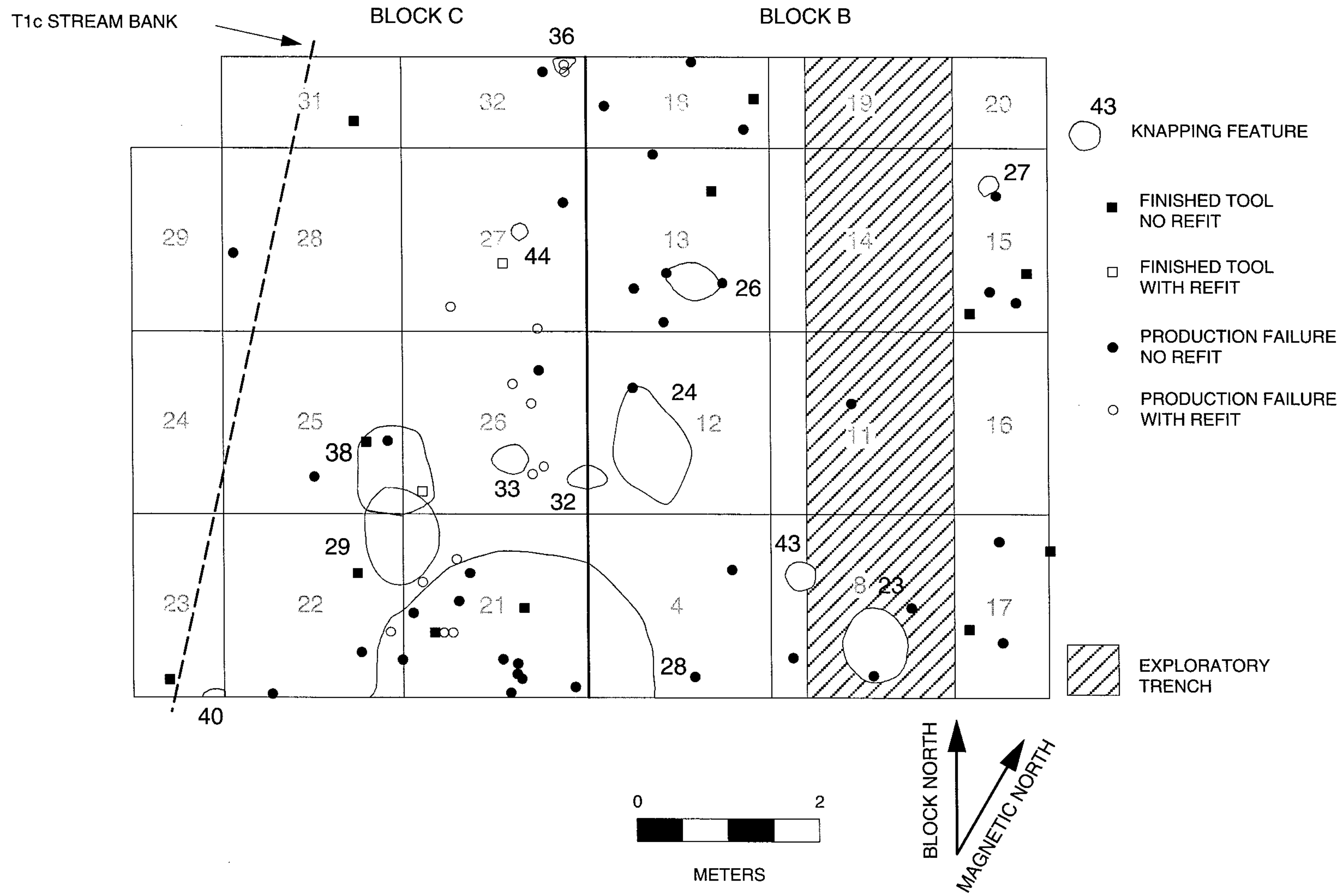


Figure 8.47. Distribution of Late Paleoindian production failures and finished tools. The relative lack of items in TUs 11, 14, and 19 is at least partly due to the incomplete excavation of the 3Ab horizon (Levels 30 and 31 only) prior to excavation of an exploratory trench in these units. Compare those units with TU 8, which was excavated to the base of the 3Ab before trenching.

Table 8.18. Finished Tools and Unfinished Production Failures from the 3Ab Horizon.

Tool	Unit-Level	Depth (cm)
Blocks B and C finished tools		
San Patrice point	TU-17-30/2	291
Unspecified scraper	TU-15-30/1	292
San Patrice point	TU-18-30/7	297
San Patrice point	F-28/19	298
End scraper	TU-31-31/1	302
Drill	TU-27-31/1	302
End scraper	TU-17-31/1	305
End scraper	TU-21-31/5	305
End scraper	TU-15-31/1	308
Utilized flake	TU-13-31/2	310
Tertiary biface	TU-22-32/1	318
Wilson point	TU-23-33A/1	322
Blocks B and C production failures		
Secondary biface	TU-13-30/4	289
Secondary biface	TU-11-29/1	289
Biface	TU-26-30	291
Secondary biface	TU-08-30/2	292
Secondary biface	TU-13-30/2	292
Primary biface	TU-15-30/2	294
Secondary biface	TU-13-30/3	294
Primary biface	TU-18-30/2	294
Preform	F28/TU-21-30-31	295
Secondary biface	TU-17-30/1	295
Secondary biface	TU-27-30/1A	295
Biface	F28/TU-21-30-31	296
Primary biface	TU-15-30/3	296
Secondary biface	TU-18-30/3	296
Primary biface	TU-04-30/5	296
Secondary biface	TU-04-SW-30/1	296
Secondary biface	TU-15-30/4	297
Preform	F28/TU-21-30-31	297
Secondary biface	TU-18-30/4	297
Biface	TU-26-30/3C	297
Biface	F28/TU-21-30-31	298
Primary biface	TU-13-30/1	298
Preform	F28/TU-21-30-31	299
Secondary biface	TU-26-30/2A	299
Secondary biface	TU-08-SW-30/1	300
Primary biface	TU-08-31/2	300
Preform	F28/TU-21-30-31	300
Preform	F28/TU-21-30-31	301
Primary biface	TU-22-31/3	302
Secondary biface	TU-27-31/3A	303
Primary biface	TU-13-31/1	304
Secondary biface	TU-27-31/2	304
Tertiary biface	TU-25-31/1	305

Table 8.18. Finished Tools and Unfinished Production Failures from the 3Ab Horizon. (Continued).

Tool	Unit-Level	Depth (cm)
Secondary biface	TU-22-31/1A	306
Preform	F24/TU-12-31	308
Primary biface	TU-21-31/3A	308
Secondary biface	TU-22-31/2	309
Primary biface	TU-21-31/4	309
Primary biface	TU-25-31/2	310
Secondary biface	TU-17-31/2	310
Secondary biface	TU-25-32/1	311
Secondary biface	F-36/2	311
Secondary biface	F-36/1B	311
Primary biface	TU-22-32/5	312
Secondary biface	TU-28-32/1	314
Block D production failures		
Secondary biface	TU-30-31	306
Primary biface	F-41	312
Secondary biface	TU-35-32	312
Secondary biface	TU-33-32	315

duction failures comprised over three-quarters (78.7%) of all bifacially and unifacially worked artifacts from Blocks B-D. In addition to the by-products of workshop activities (i.e., sheet debitage, knapping piles, and production failures), a few artifacts used for knapping were recovered from Blocks B-C, including a hammerstone and at least one grooved abrader used for platform preparation on biface edges.

In addition to its dense concentration of artifacts, the Late Paleoindian workshop area was also spatially extensive. At a minimum, the workshop midden extended from the south edge of Trench 2 through Blocks D and B-C to the cutbank, which is approximately 50 m north-south. In an east-west direction, workshop debris extended beyond the boundaries of the excavation blocks; however, it was evident in the cutbank profile that workshop material extended at least 15 m across the entire surface of the topographic high and continued onto adjacent slopes. Although the entire workshop area (at least 750 m^2) probably was not active at any one time, the site still represents a large workshop area intensively used throughout the Late Paleoindian period. Indeed, the Big Eddy site appears to represent the most intensive Late Paleoindian workshop yet discovered in the western Ozarks, and may be second only to the Olive Branch site (Gramly 1994; Gramly and Funk 1991) in the entire Ozarks region.

It is instructive to compare the Late Paleoindian workshop midden at Big Eddy with the kitchen midden discovered in the late submember (i.e., Williams component). Both midden deposits averaged approximately 30 cm in thickness. Dramatic differences are apparent in artifact composition and lithic densities (Table 8.19 and 8.20). The Late Archaic kitchen midden contained a light to moderate scatter of calcined bone and lithic artifacts and abundant amounts of wood charcoal, burned soil, and charred nut shell, whereas the Late Paleoindian midden contained a dense concentration of lithics and a light scatter of wood charcoal. Lithic density (screened) was 667 artifacts per m^3 for the Late Archaic midden (TU 5), compared to 1,746 artifacts per m^3 for the Late Paleoindian midden (TU 4). The densities of diagnostic artifacts (e.g., projectile points/knives [ppk]) are also indicative of a habitation midden vs. a workshop midden. For example, five diagnostic artifacts were recovered from 14.8 m^2 (one ppk per 2.96 m^2) in the Late Archaic kitchen midden, compared to only four diagnostics in 69 m^2 (one ppk per 17.25 m^2) in the Late Paleoindian workshop midden. Thus, the density of projectile points/knives recovered from

Table 8.19. Artifact Densities for Midden Deposits in Blocks A-D (shovel-skimmed units only).

Provenience/Depth (m)	Debitage (n)	Bifaces (n)	Volume (m^3)	Debitage Density (n/m^3)	Biface Density (n/m^3)
Block A Middle Late Archaic midden					
230–240 cm	90	3	0.5	180	6
240–250 cm	73	1	0.5	146	2
250–260 cm	8	1	0.5	16	2
Blocks B and C Late Paleoindian midden					
290–300 cm	2,820	36	5.2	538	7
300–310 cm	2,479	23	5.3	466	4
310–320 cm	905	7	4.3	212	2
Block D Late Paleoindian midden					
290–300 cm	30		0.1	300	
300–310 cm	306	3	1.3	235	2
310–320 cm	124	1	1.3	95	1

Table 8.20. Screened Artifact Densities in Blocks A, B, and D.

Block/Unit	Total Volume (m^3)	Debitage (n)	Density (n/m^3)
Block A, TU-5-SW Levels 24–26	0.30	200	667
Block B, TU-4-SW Levels 30–32	0.24	397	1,746
Block D, TU-10 Levels 30–32	0.30	126	420

the Late Archaic habitation midden was 5.8 times higher than the density of points in the Late Paleoindian 3Ab horizon.

Although there appears to be some movement of isolated artifacts between levels in the 3Ab horizon due to natural pedoturbation processes, the lithic features in Blocks B-D are essentially intact with little if any intermingling of feature contents. Most of the features were small, concentrated, circular or oval-shaped piles rather than natural splay-like deposits. The only features that appeared to contain a mixture of artifacts are the overlapping Features 29 and 38. For example, three flakes excavated from Feature 38 match Cobble 1 in Feature 29, and another flake from Feature 38 matches Cobble 4 in Feature 29. This mixture, however, may have occurred inadvertently during excavation before it was realized that the vertically overlapping knapping concentrations were separate features. Features 40, 42, and 43 provide additional evidence for relatively rapid burial (vertical accretion) and good horizontal and vertical preservation of the Late Paleoindian deposits. Each of these late-stage reduction features was arranged in a tight cluster (i.e., swept or dumped piles) in which very small microflakes (less than 1 cm^2) comprised 41–43% of the debitage. Small, light objects such as microflakes are most vulnerable to fluvial disturbance and transportation (Dillehay and Pollack 1997:289). The high density of microflakes in these features indicates rapid siltation in a relatively low-gradient, low-velocity environment.

Other early sites have produced isolated examples of discrete episodes of biface knapping. Most examples are associated with deep horizons that were buried rapidly by alluviation, much like the Big Eddy site. For example, a small lithic feature containing 17 flakes of Muldraugh chert was affili-

ated with Kirk projectile-point manufacture at the Longworth-Gick site in northwest Kentucky (Boisvert 1979:971–978). The association of discrete knapping features with Dalton or San Patrice biface manufacture is even more rare. Three knapping features, however, were discovered at Rodgers Shelter (Kay 1982a:565–570). At least two of these lithic features were associated with the Dalton horizon. These were described as "chert knapping areas...having high concentrations of lithic debitage in small areas of roughly one-foot diameter." Although the discussion of these features is brief, it appears that Dalton knapping features at Rodgers Shelter probably represented debris intentionally collected into small piles like many of those found in the workshop area at the Big Eddy site.

The best evidence for limited vertical and horizontal mixing of artifacts in the 3Ab horizon comes from the refit analysis of piece-plotted bifaces and other tool fragments (Table 8.17). Of 15 refit specimens, in 11 (73.3%) the fragments were separated vertically by 5 cm or less, three (20.0%) lacked specific vertical provenience, and in only one case (6.7%) were the fragments separated vertically by more than 5 cm (specifically 9 cm). In general, horizontal distances between piece-plotted refit specimens were relatively short (<2 m). Only two Refits ("d" and "e") were separated by significant distances (2.5 m and 8.5 m). The directionality between refit specimens also indicates cultural dispersal as opposed to natural dispersal. For instance, of 12 refit examples with indications of directionality (excepting Refits "g", "l", and "o"), six had a north-south orientation, five had an east-west orientation, and the orientation of one example (Refit "a") was both north-south and east-west. Directionality of naturally (i.e., fluvially) dispersed artifacts would have been predominantly in one direction (e.g., north-south or east-west) depending on direction of stream flow during late Pleistocene times. Limited refit analyses of Rodgers Shelter material resulted in at least three mended bifaces from the Dalton horizon. Biface fragments were separated by horizontal distances of 70 cm, 113 cm, and 152 cm; the vertical separations were all less than 21 cm (Kay 1982a:569).

Finally, a preliminary study of the angle of repose and orientation (i.e., ventral or dorsal side up) of flakes was conducted for indications of cultural vs. natural (fluvial) depositon of debitage. These observations were made on 80 flakes exposed in the 3Ab horizon in the vertical cutbank. These flakes occurred within and around a sparse scatter of alluvial gravel (gravel feature) south of the southeast corner of Block B. The same observations were made on 82 flakes recovered during the excavation of knapping Feature 42 in Block D (Table 8.21). It should be pointed out that it was more difficult to determine angle of repose for flakes in Feature 42 (while excavating in plan view) compared to the flakes eroding from the vertical cutbank. Flakes larger and smaller than 1 cm^2 were considered in Feature 42, whereas only flakes larger than 1 cm^2 were included in the cutbank study. The orientation (ventral or dorsal) of a few flakes with very high angles could not be determined.

The angle of repose of the vast majority (86%) of flakes excavated from the cutbank was low (less than 30°); indeed, most (74%) of these exhibited repose angles of <10°. The percentage of flakes in Feature 42 (knapping pile) with angles of repose ≤30° was also high (over three-quarters), but less than that for flakes in the cutbank. These observations indicate that the vast majority of Late Paleoindian debitage was deposited on a relatively level surface, and that most have been relatively well preserved with limited postdepositional bioturbation and/or cultural disturbances. Natural fluvial deposition of flakes, especially flakes found in concentrations such as Feature 42, would exhibit an imbricated (stacked in a slanted) pattern with predominant angles of approximately 30–45°. Ventral side up was the more common flake orientation in both locations.

A brief experiment was conducted for comparative purposes with the above archaeological data (Table 8.21). One hundred primary and secondary flakes (all >1 cm^2) were knapped from several Burlington chert nodules onto a dirt surface from a squatting position. The resulting knapping pile measured about 45 x 60 cm with approximately 25% of the flakes lying on top of or against other flakes. Angle of repose and flake attitude (dorsal or ventral) were recorded for each flake. The experiment revealed that 90% of the flakes in the knapping pile exhibited an angle of repose of less than 30°. Those flakes with angles greater than 30° were either lying against other flakes or had stuck in the dirt in a vertical or near-vertical position upon impact with the ground. A slight majority of the experimental flakes rested with the dorsal side up. The experimental data compare favorably with the flake data obtained from the cutbank and Feature 42, which supports the inference that the workshop

Table 8.21. Size and Attitude Data for Selected Debitage Samples.

	Cutbank		Feature 42		Experiment	
	N	%	N	%	N	%
Angle of repose						
0–30°	69	86.2	63	76.8	90	90.0
30–60°	3	3.8	13	15.9	7	7.0
60–90°	8	10.0	6	7.3	3	3.0
Total	80	100.0	82	100.0	100	100.0
Flake size						
<1 cm^2			43	52.4		
>1 cm^2	80	100.0	39	47.6	100	100.0
Total			82	100.0		
Flake orientation						
Ventral	51	65.4	42	58.3	48	48.0
Dorsal	27	34.6	30	41.7	52	52.0
Total	78	100.0	72	100.0	100	100.0

debitage was deposited by cultural means as opposed to natural (i.e., fluvial) processes.

Spatial Organization

With the current data, it is impossible to determine whether the Dalton, San Patrice, and Wilson occupations at Big Eddy were separate or simultaneous. Assuming local vs. nonlocal residency (see below), however, it is probable that the majority of occupations were separate, with possible occasional concurrent occupation in relation to periodic rendezvous for the exchange of material goods and other commodities. Regardless of separate vs. simultaneous occupations, current evidence suggests that Dalton and San Patrice uses of the sampled parts of the Big Eddy site were somewhat different. Spatial information on the San Patrice component is limited, but the recovery of multiple projectile points, one drill, and several probable San Patrice preforms suggest that the portion of the site in the vicinity of Blocks B and C was utilized by the San Patrice occupants as both a habitation area and a lithic workshop.

Dalton tools are more common at Big Eddy and have been recovered from different locations across the site. The recovery of several Dalton preforms from Blocks B-D and the paucity of Dalton utilitarian tools indicates that Dalton occupants used this area primarily as a locus for stone-tool manufacturing. Two hafted end scrapers (possibly Dalton) were recovered from Blocks B-C; however, both were fragmentary and found in association with lithic knapping piles (Features 28 and 29), so they may represent discard of broken tools in the workshop area after retooling. The same could apply to the bevelled tertiary-biface (apparent Dalton point) fragment found in Block C. Few other finished (utilitarian) tools that could be considered Dalton or potentially Dalton were recovered during the excavation of Blocks B-D. The evidence obtained from areas outside the excavation blocks comes from cutbank monitoring by project personnel and by private collectors, the latter of which was selective by nature with less accurate provenience data. Nevertheless, the evidence gathered suggests that Dalton habitation areas may have been intentionally separated from the workshop area. According to two long-time collectors, Dalton points were found more frequently 10–15 years ago when the cutbank was estimated to be 6.1–9.2 m to the south (Dan Long, personal communication 1997; Terry Collins, personal communication 1997; see also Ziegler 1994:52). Unfortunately, the specific locations of the private-collector finds along the extensive cutbank were not recorded.

The 1997 cutbank monitoring (over three months), however, provided more detailed information on artifact types and specific locations. That portion of the cutbank located directly south of Blocks B-C produced one Dalton point, three hafted end scrapers, one adze, nine failed preforms (primary and secondary bifaces), a moderate debitage scatter, and at least one knapping feature. This collection suggests that both habitation and workshop activities were performed approximately 8 m south of Blocks B-C. Repeated examinations of cutbank areas to the west (downstream) and east (upstream) of Blocks B-C, however, revealed considerably different types and densities of artifacts. For example, that portion of the 3Ab approximately 25 m west of Blocks B-C yielded one Dalton point, one Dalton adze, one hafted end scraper, no knapping features, and very little debitage. Similarly, the cutbank located approximately 60 m east of Blocks B-C yielded one Dalton point and only a few flakes. Recent discussions with two private collectors indicate that at least one and possibly two additional Dalton points were retrieved from this location. As a result of these finds, it is clear that Dalton artifacts occur on buried landforms downstream and upstream of Blocks B-C. Preliminary geomorphic interpretations are that a low-relief ridge-and-swale topography occupied the Sac River bottomland at the Big Eddy locality during late Pleistocene times. Dalton groups apparently occupied at least two low-relief ridges in this bottomland setting.

Based on the preliminary data at hand, therefore, it is inferred that Dalton occupants organized domestic (habitation) and workshop activities at the site in the following manner. The ridge that Blocks B-D intercepted was utilized primarily as an intensive workshop area (at least that portion located 8–42 m north of the cutbank). The core area of the lithic workshop was in Blocks B-C, especially the southern half, which yielded a density (for screened areas) of 1,746 artifacts/m^3. This density is 4.2 times greater than that for TU 10 in Block D (Table 8.20), which indicates that Block D is probably located on the northern periphery of the Late Paleoindian workshop area. That portion of the ridge located 8+ m south of Blocks B-C apparently hosted a mixture of habitation and workshop activities. In contrast, adjacent ridges to the west and east (at least those sections exposed by the present cutbank) appear to have been utilized primarily as habitation areas. Additional excavations, however, need to be conducted in these buried landforms to test these preliminary conclusions of differential Late Paleoindian land use.

There is little doubt that the primary Late Paleoindian activity in the area of Blocks B-D was the manufacture of chipped-stone tools, especially bifacial tools. Nevertheless, several other activities occurred at the Big Eddy site during Late Paleoindian times. These include heavy-duty woodworking with chipped-stone adzes; the drilling of semihard and hard materials such as wood, bone, antler, shell, and/or stone; processing hides and other materials with hafted end scrapers and side scrapers; engraving, incising, and/or piercing materials with graver spurs and burins; processing materials with manos and flat abraders; and the processing of iron ore (hematite and limonite) for pigment. Most of the iron ore fragments recovered from the Late Paleoindian horizon were small and may have been pulverized with a mano and anvil stone; however, one relatively large chunk appears to have been processed via scratching and gouging.

Although no hard physical evidence was encountered in our excavations, hearths appear to have been present in the general vicinity of Blocks B-C. At least three lines of evidence support this assumption. First, numerous small fragments of wood charcoal are scattered throughout the 3Ab horizon. Second, several bifaces and other chert artifacts recovered from Blocks B-C exhibit potlids, crazing, and other attributes indicative of direct contact with fire. Third, a small percentage of alluvial gravel in Blocks B and C exhibit unnaturally angular, fire-cracked fractures and highly oxidized, fire-reddened cortical surfaces. Hearths have been firmly associated with Dalton components at other sites. Perhaps the best example is Rodgers Shelter, where at least 21 hearths or hearth-like features were recorded in the Dalton horizon, mostly in alluvium (Kay 1982a:562; McMillan 1976a:223-224).

Lithic Technology and Reduction Strategies

A much larger sample of in situ diagnostic projectile points/knives needs to be recovered from the Big Eddy site. However, the present preliminary data suggest a linear technological progression from the full-facial fluting of earlier Gainey points (see below), to short shallow flutes and/or basal thinning of San Patrice and early Dalton points, to the absence of shallow flutes and basal thinning on later early Early Archaic forms. Dalton points perhaps best illustrate this diachronic trend.

A small percentage of Dalton points are actually fluted (Chapman 1975; Hofman and Wyckoff 1991; Morse 1997). Indeed, the Dalton variant (Figure 8.34c) recovered from the Big Eddy site by a private collector exhibits flutes on both faces (2.0 and 2.5 cm long). Of the two Dalton points recovered from in situ contexts at Big Eddy, one was from the base of the 3Ab horizon and one was from the very top of the 3Ab horizon. Based on radiocarbon dates and estimated rates of aggradation, the lower and upper boundaries are separated by a span of approximately 450 years. The Dalton fragment found at the base of the 3Ab horizon exhibits multiple long basal thinning scars on both faces, whereas the Dalton fragment recovered from the top of the 3Ab horizon lacks any basal thinning.

Other postulated diachronic technological changes made by Dalton knappers are related to basal shape, thickness, and strong alternate blade bevelling. Initial-stage early Dalton points are generally large, lanceolate, thin, and lenticular (nonbevelled) in cross-section, with broad, relatively shallow concave bases. Resharpened specimens are usually only slightly bevelled and the bevelling appears to be more bifacial than alternate. The lanceolate form extends from the distal end to the base with only a hint of a stem-blade juncture. In contrast, later, presumably terminal, Dalton forms are usually smaller, thicker points with strong bevelling, a more well-defined stem-blade juncture with incurvate lateral stem edges, and sometimes deeply concave (bifurcated) bases. The strongly bevelled (Dalton-like) Graham Cave point found only 20–25 cm above the top of the 3Ab horizon may actually represent a terminal Dalton or transitional Dalton–Graham Cave point. Obviously, a much larger sample of early to terminal Dalton points needs to be recovered from good stratigraphic contexts to support or refute these postulated diachronic trends.

San Patrice bifaces also appear to have roots in the fluted-point tradition. Many San Patrice points exhibit true deep flutes that often extend the length of the blade. Each of the three San Patrice dart points found in Blocks B-C have flutes, but the flutes are comparatively short and shallow. The fluting (probably percussion) is rather distinct, however, from the long, narrow (pressure) thinning scars on most Dalton points. Although it is tempting to interpret the corner-notched St. Johns variety as a later, terminal style of the Hope variety of San Patrice, there was little or no vertical separation between the Hope and St. Johns varieties at Big Eddy. The location of all three specimens in the upper portion of the 3Ab horizon precludes any discussion of diachronic trends in San Patrice lithic technology.

In contrast to Dalton and San Patrice points, Wilson points show little evidence of coming directly out of a fluted-point tradition. They exhibit no fluting and little or no basal thinning. Nevertheless, the recovery of several Wilson points stratified between Middle Paleoindian and Early Archaic lanceolate points at the Wilson-Leonard site (Collins 1998), and one apparent Wilson point from a sealed context (at the base of a gravel deposit) at the Big Eddy site, indicate they represent a Late Paleoindian manifestation. The recovery of the Wilson projectile point/knife, as well as the smaller St. Johns variety dart points, from the upper half of the 3Ab horizon at the Big Eddy site, is proof that corner notching has its origins in Late Paleoindian times and that Wilson and San Patrice points are coincident with at least late Dalton.

The relatively undisturbed workshop area at Big Eddy provided a unique opportunity to study Late Paleoindian raw-material selection and reduction strategies. Although most of the knapping features could not be associated with a specific component (i.e., either Dalton or San Patrice), enough aborted Dalton and San Patrice preforms were recovered to reveal similar strategies in raw-material selection and reduction. Both groups were highly selective for Jefferson City chert (especially the Ellipsoidal variety), the majority of which was collected from alluvial sources (see Chapter 9). Thin Ellipsoidal Jefferson City chert cobbles provided natural preforms that required only decortication and minimal subsequent thinning.

Both Dalton and San Patrice knappers adopted a cobble-blank reduction strategy to take advantage of this high-quality raw material that occurred in natural preforms. This is indicated by the presence of alluvial-cobble cortex on both sides of several primary and secondary bifaces, the relative lack of formal flake-blank cores, and a high percentage of biface (thinning) flakes. In addition to Ellipsoidal Jefferson City chert, the cobble-blank method appears to have been used for the reduction of most of the other local chert resources with the possible exception of Burlington chert, which occurs in large, blocky forms. At least one aborted primary biface was apparently reduced by the flake-blank method. Although more Burlington chert preforms need to

be recovered and studied to confirm a flake-blank strategy, it is possible that the particular reduction strategy used by Late Paleoindian knappers was highly adaptable (or opportunistic) and dependent on raw-material morphology.

Local vs. Nonlocal Residency

The Dalton component at Big Eddy is interpreted as representing the resident Late Paleoindian occupation. Although Morse (1997:125–126) asserts that the Dalton manifestation was centered in the central Mississippi River valley on the southeast side of the Ozark Highlands, Dalton sites are well represented and Dalton points are found in significant numbers throughout the Ozarks. The Dalton type site is a prolific buried site in Cole County, Missouri (Chapman 1948:138; 1975:135), and Dalton points have been found in nearly every topographic setting across the entire state (O'Brien and Wood 1998:73). The Dalton manifestation also extends west and southwest of the Ozarks into eastern Kansas, eastern Oklahoma, and even into San Patrice territory of northeast Texas (Johnson 1989:Figure 3; Justice 1987:41; Turner and Hester 1993:99). In southwest-central Missouri, Dalton comprised a significant early component at Rodgers Shelter (McMillan 1976a:223–224; Kay 1982e:544), and, based on the quantity of diagnostics, Dalton was the dominant Late Paleoindian component at the nearby Montgomery site (Collins et al. 1983). Although the exact nature of Dalton territoriality and settlement patterning is somewhat controversial (Morse 1971; Price and Krakker 1975; Schiffer 1975), it is generally believed that Dalton bands were indigenous residents of the Ozarks and adjacent regions (Kay 1982c:739).

The San Patrice component at Big Eddy, on the other hand, is interpreted as representing activities of a nonlocal or nonresident group(s) that made periodic forays into the southern Ozarks. The San Patrice manifestation is generally found to the south in the Gulf Coast and southern Plains areas (Collins 1995; Ensor 1986) and extends westward to the eastern edge of the southern High Plains (Willey et al. 1978). The San Patrice heartland, however, appears to be located in northwestern Louisiana and northeastern Texas (Johnson 1989:22). A close relative or regional variation of San Patrice is the Hardaway type found in the southeastern United States (Justice 1987:43), particularly the Carolinas and surrounding states. Indeed, the San Patrice and Hardaway types may represent a related pan-southern expression of Late Paleoindian that was contemporaneous with Dalton.

San Patrice points have been found in Missouri (O'Brien and Wood 1998:98, 133) but never in large quantities. They certainly are never found in numbers comparable to Dalton points. As an example, the ratio of Dalton to San Patrice points found at the Montgomery site was 39:1 (Collins et al. 1983:30, 35). Nevertheless, there are enough examples of San Patrice points to indicate that the southern Ozarks region was well within the range of the San Patrice culture. San Patrice points are known from at least three sites in the Sac River valley and the neighboring Pomme de Terre River valley: one Hope variety and two St. Johns variety from the Big Eddy site, one Hope variety from the Montgomery site (Collins et al. 1983:Figure 17c), and two St. Johns variety from Rodgers Shelter (Ahler 1971:10–11; Kay 1982e:501–505). Another San Patrice–like specimen from an unspecified site in central Cedar County was noted in the collection of Dan Long. Several San Patrice specimens have been found south of the project area. For instance, Marshall (1958:101, 165) noted San Patrice–like bifaces in the Table Rock Lake area, and one nicely fluted St. Johns variety San Patrice (see Figure 8.50c) was found by Don Dickson at the confluence of the Kings and White rivers in Barry County, Missouri. Another complete (but exhausted) specimen (Hope variety) was found by Pete Peterson on Big Creek (23TA366) in southeast Taney County. In addition, one San Patrice–like or Pelican point with a nearly full-facial flute was recovered from disturbed deposits at Spradley Hollow Shelter in Newton County, Arkansas (Cande 1998). Two of the last three specimens were knapped from Lower Reeds Spring chert.

There are undoubtedly other examples from the Ozarks, but their rarity and low frequency at any one site indicates a sporadic and relatively ephemeral nature to the San Patrice occupations. Outside the Ozarks, numerous specimens of San Patrice (Hope and St. Johns varieties) have been reported in the Western Lowlands of northeast Arkansas (Redfield 1969).

Although relatively rare, lanceolate Dalton points and San Patrice points apparently have been found together at the Hester site in Mississippi (Sam Brooks, personal communication 1998). In the Ozarks region, Dalton and San Patrice points have been recovered from a common site (e.g., Rodgers

Shelter and Montgomery site), but prior to the Big Eddy site, they had never been found in the same stratum. The lone (Hope) San Patrice point from the Montgomery site was found out of context, and unless San Patrice extends into Middle Archaic times (unlikely), the two (St. Johns) San Patrice points at Rodgers Shelter were found in disturbed contexts. Based on stratigraphic evidence from the Big Eddy site, they were clearly coeval point types, at least ca. 10,200–10,000 B.P. The significance of the co-occurrence of Dalton and San Patrice points at sites in the western Ozarks is unknown. It could be fortuitous, or it could reflect established ties between the two cultural entities.

It is tempting to view the San Patrice peoples as Ozark interlopers, but the actual relationship between Dalton and San Patrice is probably much more complex. Although Dalton and San Patrice may represent two separate cultures, it seems more probable that they represent a divergence from a common cultural tradition. Most investigators accept the latter interpretation and consider them sister cultural traditions (Ensor 1986; Johnson 1989). Their material culture and lithic technologies are similar in overall design, which suggests a common adaptation to the Eastern Woodlands, while allowing for regional (north vs. south) variation reflected by slightly different tool kits. If the latter interpretation is correct, it is not unreasonable to assume that southern affiliates would periodically make trips to the north for social visitation and/or exchange of goods, and vice versa. If this is an accurate portrayal of Late Paleoindian settlement practices, it is probable that Dalton occupations at the Big Eddy site were more long term and more intensive than San Patrice occupations. This appears to be supported by diagnostic and potentially diagnostic artifacts. Unless there was an occasional rendezvous event, most Late Paleoindian occupations at Big Eddy probably represent site use by small groups of hunter-gatherers.

It is difficult to assess the nature of a possible Wilson component at the Big Eddy site. It is tentatively proposed based on a single projectile point/knife. If we assume that the southern Plains area of central Texas is the home range of Wilson points, it is probable that Wilson points, like San Patrice points, are not a common phenomenon in the Ozarks. If so, a Wilson component at Big Eddy would reflect activities of a second nonlocal group that made periodic trips or forays of relatively short duration into the western Ozarks.

EARLY/MIDDLE PALEOINDIAN

Relatively few Early and/or Middle Paleoindian sites have been discovered in the Ozark Highlands and surrounding areas. Three sites in northern Missouri are highly controversial: Shriver (Reagan et al. 1978), Miami Mastodon (Hamilton 1993; O'Brien and Wood 1998), and Walters (Biggs et al. 1970). It is unclear whether the Walters site is entirely Late Paleoindian (i.e., Dalton) or if it contains some fluted Early/Middle Paleoindian material (Biggs et al. 1970:51–54). Two widely recognized Early Paleoindian sites in the eastern Ozarks are Kimmswick (Graham et al. 1981; Graham and Kay 1988) and Martens (Koldehoff et al. 1995; J. Morrow 1996). Unfortunately, there are no radiocarbon dates from either site. Other nearby Early/Middle Paleoindian sites in western Illinois are Ready/Lincoln Hills (Koldehoff 1983; Morrow 1995), Bostrom (J. Morrow 1996; Tankersley 1995; Tankersley et al. 1993), and Klostermeier (J. Morrow 1996). Radiocarbon ages are lacking from these sites as well. In northwest Arkansas, excavations at the Skaggs site produced Early Paleoindian (Clovis/Goshen) and Late Paleoindian (Dalton) artifacts; unfortunately, all were recovered from shallow deposits with no meaningful stratigraphic context (Robert Mainfort, personal communication 1998). It is important to note that, with the exception of Kimmswick, all of the above Early/Middle Paleoindian sites are in upland locations. Cultural deposits at Kimmswick were shallowly buried in thin, mixed colluvial-alluvial deposits overlying a terrace in a small valley tributary to the Mississippi Valley. In comparison, the Big Eddy site is unique in that it contains the only known Early/Middle Paleoindian deposits found in a deep, stratified, alluvial context in the Ozarks or surrounding areas.

Hand excavations in the Early/Middle Paleoindian deposits were conducted primarily in Blocks B and C. A total of 11.3 m^3 was excavated via shovel skimming in 5-cm increments. The majority of this work was limited to 320–350 cm bs (Levels 33–35) in a 36-m^2 area in the west-central portion of Blocks B-C. Deeper deposits (below Level 35) were excavated in units TU 4, TU 16, and TU 23–25; however, the deposits in TU 23 and TU 24 equate only to the upper 10–20 cm of the Early/Middle Paleoindian horizon due to their location on the dipping T1c stream bank.

Hand excavations in Early/Middle Paleoindian deposits in Block D were restricted to two lev-

els in TU 10 (1 m^2). Nevertheless, the recovery of three flakes in Levels 33 and 34 as well as the discovery of a flake at approximately 360 cm bs in the north wall of Trench 2 indicate that Early/Middle Paleoindian deposits probably extend at least 25–30 m to the north of Blocks B and C.

Clovis/Gainey Components

At least three fluted projectile points/knives have been recovered from the cutbank of the Big Eddy site by two private collectors. Unfortunately, all were found out of context on slump deposits. Two fluted points are represented in the Dan Long collection. One appears to be a nearly completed production (preform) failure knapped from exotic Lower Reeds Spring chert (Figure 8.48a). The large basal fragment (4 cm wide) exhibits convex lateral edges and a moderately concave base. On one face it exhibits a 1-cm-wide flute that extends 3.5 cm to a transverse fracture. It also exhibits two relict nipple platforms prepared to guide the opposite flute that was never made, apparently because failure occurred during intervening lateral thinning. It has no lateral or basal grinding. Long's second fluted point is a thin Folsom-like fragment exhibiting parallel sides and two narrow flutes (0.7–0.9 cm wide) that probably extended well beyond the transverse snap fracture (Figure 8.48b). Both lateral edges and the base are lightly ground for hafting. This point fragment, which was finished and broken during use, is 3.5 cm long x 2.0 cm wide. Terry Collins also found a fluted point approximately 8 m west of Block C. This fluted-point fragment, which broke at the haft (Figure 8.48c), exhibits a transverse snap fracture. It has moderate lateral and basal grinding and its flutes are 1.0 cm and 1.5 cm wide. The lateral edges of the basal fragment are slightly convex.

A primary goal of the 1997 excavations at the Big Eddy site was to discover the stratigraphic context of the Early/Middle Paleoindian component(s) indicated by the fluted points in the Long and Collins collections. During the final days of the project, at least one fluted point and an associated Early/Middle Paleoindian artifact assemblage were recovered from the 3Btb1 horizon immediately below the Late Paleoindian horizon. This represented the unprecedented discovery in midcontinental North America of a fluted-point horizon in an undisturbed, alluvial, stratified context below succeeding Dalton and San Patrice materials (Ray et al. 1998).

The Late Paleoindian–Early/Middle Paleoindian boundary in the early submember occurs at approximately 320 cm bs in the Block B-C vicinity. Based on the recovery of two fluted-point refit fragments (separated vertically by only 1 cm), a second probable fluted-point fragment, and an associated moderate scatter of debitage, one apparent Early/Middle Paleoindian living surface was delineated at 330–333 cm bs. Due to a lack of diagnostic artifacts and a relatively light artifact density, the base of the Early/Middle Paleoindian component is difficult to assess. It appears to extend to a depth of at least 350 cm, below which a significant drop in artifacts occurs. A sparse scatter of lithics, however, continues to 370 cm bs, which is where the base of the Early/Middle Paleoindian component is tentatively delineated.

Debitage

The Early/Middle Paleoindian flake debitage comprised only a fraction (approximately one-fifth) of the debitage found in the overlying Late Paleoindian horizon (Table 8.1). Although initial-reduction artifacts (primary and secondary flakes) are represented in the Early/Middle Paleoindian assemblage, the majority of the debitage reflects middle-to late-stage reduction (i.e., biface thinning). This is also reflected in the relative lack of core debitage: one tested cobble and one working core. The working core was recovered from TU 22 at a depth of 330–334 cm. It is conical or triangular prismatic in shape (Figure 8.49k) with maximum length, width, and thickness of 8.28 cm, 5.19 cm, and 4.56 cm, respectively. Approximately 80% of the original (natural) platform is flaked or faceted. It appears to be a formal blade core with most of the negative blade scars extending from the proximal (platform) end to the distal end around the entire circumference of the core. The core exhibits a minimum of six to nine blade facets. The longest blade scar is 4.93 cm in length. It is noteworthy that the blade core was made from a high-quality cobble of Oolitic Jefferson City chert. It would be very difficult to make a blade core from a nonspherical nodular chert such as Ellipsoidal Jefferson City chert, which comprises the vast majority of (bifacial) reduction debitage in the Early/Middle Paleoindian assemblage (see Chapter 9).

The products of blade cores, of course, are elongated flakes called blades. Following Johnson (1983:50) and Parry (1994:87), true blades have a

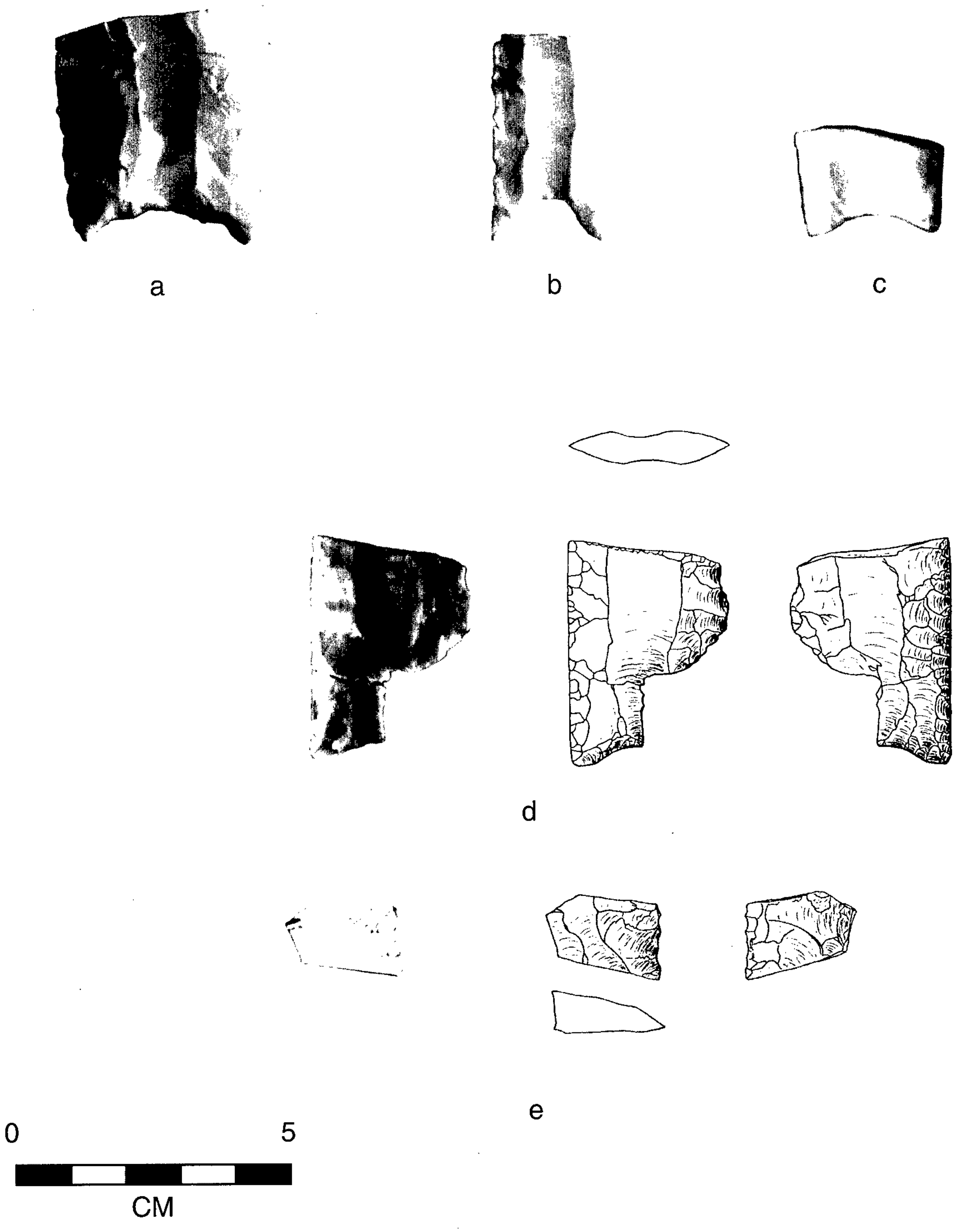


Figure 8.48. Early/Middle Paleoindian projectile points/knives: (a) Gainey preform failure; (b) Eastern Folsom/Sedgwick point; (c) indeterminate (Clovis or Gainey) fluted-point fragment; (d) Gainey refit specimen; (e) indeterminate (Clovis or Gainey) fluted-point fragment.

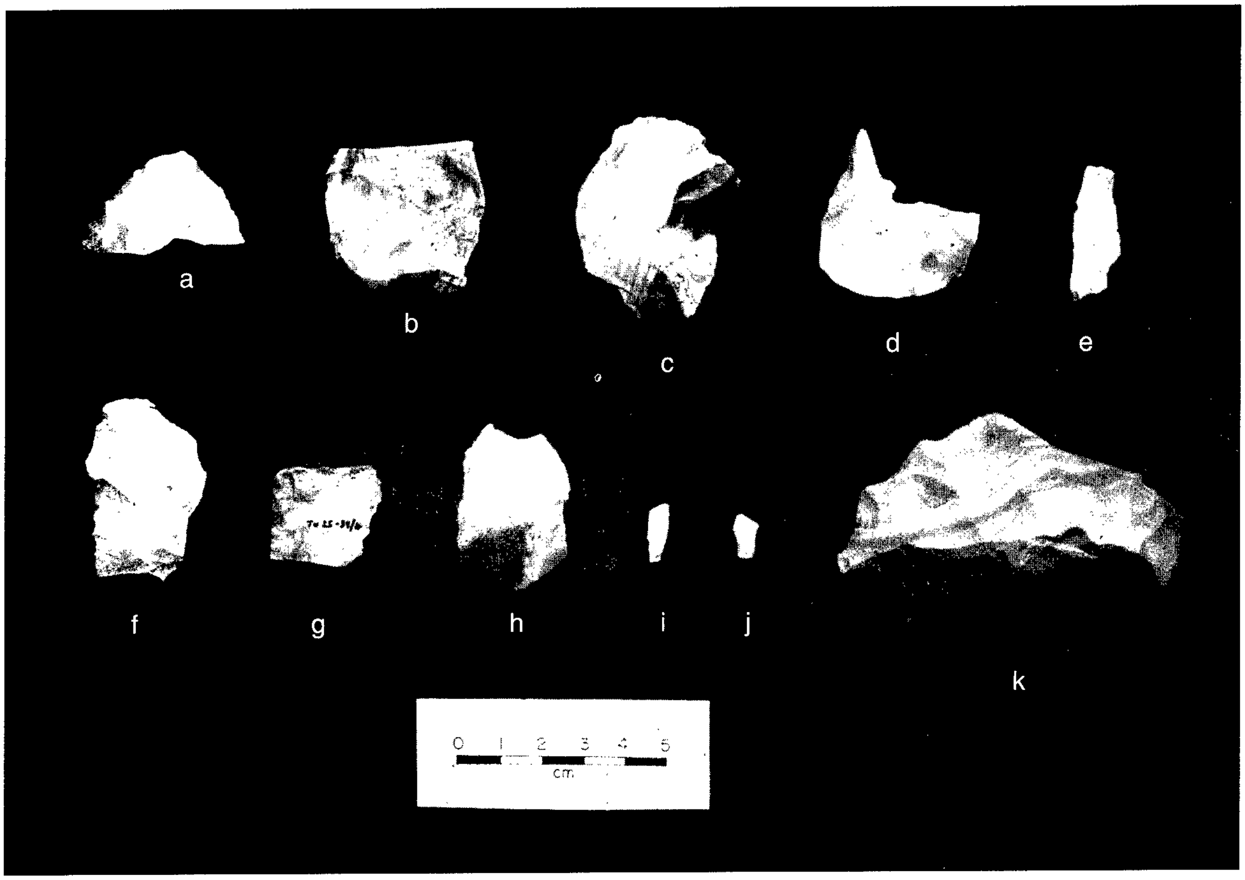


Figure 8.49. Early/Middle Paleoindian tools: (a-b) secondary biface production failures; (c), end scraper; (d) graver; (e) utilized blade; (f-j) utilized flakes; (k) blade core (platform side down).

length-width ratio >2:1, have parallel lateral edges, exhibit at least one linear dorsal ridge with adjacent parallel blade scars, and have a triangular or trapezoidal cross-section. Using this definition, only five artifacts in the Early/Middle Paleoindian assemblage appear to qualify as blades. All but one are complete flakes. Three are classified as biface flakes, one is a tertiary flake, and one is a utilized flake fragment (Figure 8.49e). Most are relatively small, ranging from 1.5–3.7 cm in length. None refit with or match the above blade core in raw-material type. Although exhibiting attributes indicative of true blades, it is quite possible that most of these specimens simply represent fortuitous blade-like flakes produced during bifacial core reduction. Blade cores and blade products have been associated with Clovis technology (Collins 1990; Freeman et al. 1996; Green 1963; Sanders 1990; Tankersley 1994), but they appear in varying quantities on Clovis sites (Bradley 1991; Parry 1994). No large, thick curved blades described from some Clovis sites (Freeman et al. 1996; Haynes 1982:338–339; J. Morrow 1996:34) were found at the Big Eddy site. In eastern Missouri and western Illinois, blades appear to comprise a relatively minor portion of Early/Middle Paleoindian lithic assemblages (J. Morrow 1996:256). Similarly, blades do not appear to comprise a significant part of the Early/Middle Paleoindian assemblage at the Big Eddy site, although they were being manufactured.

Nondiagnostic Chipped-Stone Tools

Nondiagnostic tools consist of six informal tools and four formal tools. The informal tools are utilized flakes, all of which were found in Levels 34 and 35 (330–350 cm bs). One of these (Figure 8.49e) is the small blade mentioned earlier. Two other utilized specimens are very small (1.07 and 1.45 cm) microflakes with use wear on one side only. These

utilized microflakes (Figure 8.49i-j) appear to be too small to have been hand held and may have been socketed into a handle. Small microblade cores have been identified at the Shoop site in Pennsylvania (Witthoft 1952). A small, apparently specialized form of utilized flake, however, has rarely, if ever, been reported from Early/Middle Paleoindian sites in the Midwest. The remaining three utilized specimens represent irregular waste flakes with use wear on one side only (Figure 8.49f-h). Two of these exhibit relict cortex on the dorsal surfaces. Five of the utilized flakes were knapped from Jefferson City chert (four of the Ellipsoidal variety) and one was knapped from Burlington chert.

The four nondiagnostic formal tools are two secondary bifaces, one end scraper, and one graver. The two secondary bifaces (Figure 8.49a-b) represent failed preforms. One is a distal fragment and the other is a proximal fragment; both exhibit transverse snap fractures. The basal fragment broke early during biface reduction and shows no evidence of platform preparation for fluting. These Early/Middle Paleoindian production failures, both knapped from Jefferson City chert, were found at 330–335 cm bs and 347 cm bs. The reduction technique is indeterminate; however, at least the distal fragment made from Ellipsoidal Jefferson City chert is likely to have been knapped from a cobble blank. Manufacture of biface preforms from local raw materials was not as intensive as during the subsequent Late Paleoindian period at Big Eddy, but it obviously was an important activity. These preforms, recovered in association with over 500 pieces of reduction debitage, represents the only workshop assemblage recovered from a deeply buried Early/Middle Paleoindian context in the Midwest. It is impossible to determine the specific purpose of the preform manufacturing; however, there are at least two possibilities. The preforms may have been the end product to be transported into neighboring chert-poor areas, or they may simply represent on-site biface retooling. No channel-flute flakes indicative of on-site fluting were observed in the debitage collection. Preform fluting was conducted at the Big Eddy site, however, based on the partially fluted preform (Figure 8.48a) recovered by Dan Long several meters south of our block excavations.

Two unifacial tools were recovered from the Early/Middle Paleoindian horizon: one end scraper and one graver. The end scraper (Figure 8.49c) was found in Level 34 (330–340 cm bs). It was made from a cortical secondary flake with the proximal end at the bulb of percussion and scraping end at the recurved distal end. The platform is too fragmentary to determine whether the secondary flake was struck from a prepared conical core or a bifacial core. Unlike most Late Paleoindian end scrapers, it exhibits no elongated haft element. In addition, the proximal end is 1.6 cm thick and triangular in cross-section. This unifacial flake tool may represent an expedient, perhaps unhafted, scraper. The graver was found between 325 and 330 cm bs. It consists of a retouched edge on a fortuitous sharp projection of an irregularly shaped tertiary flake (Figure 8.49d).

Diagnostic Chipped-Stone Tools

Only one diagnostic artifact was recovered from the Early/Middle Paleoindian deposits during the 1997 excavations. It is a full facially fluted fragment (Figure 8.48d) recovered in situ in Block C (TU 25) at a depth of 330–331 cm. Remarkably, two refit (midsection and basal) fragments of the same point were found 35 cm apart, separated vertically by only 1 cm. This broken fluted point exhibits a transverse snap fracture 4.12 cm from the basal margin and an irregular thermal-shock fracture across the stem, approximately 1.67 cm from the base. The point, which was manufactured from fine-grained Burlington chert, appears to have broken at the haft during use and was subsequently discarded into a fire. The fluted fragment has moderately ground lateral edges from the base to the transverse break, and it exhibits flutes the entire length of the fragment on both faces. The flutes vary from 1.05–1.24 cm wide. The basal fragment is 2.99 cm wide with a maximum thickness of 0.64 cm and a minimum thickness of 0.53 cm between channel flutes. The transverse fracture exhibits minute nibbling along one face, indicating either incidental damage during tensile snap in the haft or temporary recycling as a scraping tool before rejection. Several Clovis bifaces from the Adams site exhibit use wear on fracture edges, indicating they were presumably utilized as scraping tools after breakage (Sanders 1990:38-50). Future microwear analysis should determine whether the apparent use wear on the Big Eddy point fragment was produced intentionally or accidentally.

Another biface fragment also appears to represent a broken fluted point. It is a well-made blade (lateral edge) fragment found at a depth of 333 cm

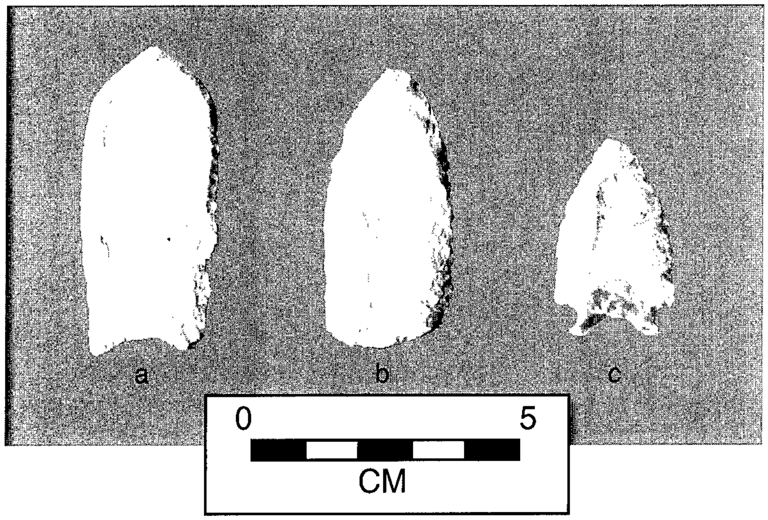


Figure 8.50. Fluted points from southwest Missouri: (a) Folsom; (b) Eastern Folsom/Sedgwick; (c) San Patrice (St. Johns variety) (photographed by the author, courtesy of Don Dickson).

bs near the above fluted point. Although the blade fragment is temporally nondiagnostic, two flake scars evident on one face appear to represent a guide flute and a very small section of an adjacent channel flute (Figure 8.48e). The reverse face exhibits only a hint of the outside margin of a possible flute scar. This biface edge fragment, which was also knapped from Burlington chert, is 0.68 cm thick. The irregular multiple fracture pattern suggests that this bifacial tool may have been intentionally broken, or it may have shattered upon impact with a solid object.

The five fluted projectile points/knives recovered from cutbank and in situ contexts at the Big Eddy site are difficult to type due to their fragmentary condition. Some have Clovis-like attributes, whereas others share attributes said to be characteristic of Gainey points (Deller 1989:199; Ellis 1984; Roosa and Deller 1982:4; Simons et al. 1984:269). For example, the refitted fluted point (Figure 8.48d) is parallel sided and exhibits long, wide flute scars; however, the basal concavity is neither deep or rounded. Two specimens found on the cutbank (Figure 8.48a and c) have convex sides, more characteristic of Clovis points. One (Figure 8.48a), however, is an unfinished preform, and the other (Figure 8.48c) is only a basal fragment. The small, thin specimen in the Long collection (Figure 8.48b) is nearly complete, missing only the tip. It is parallel sided with long, wide flutes as well as a deeply concave base. However, it is very thin and symmetrically biconcave in cross-section; thus, it bears a strong resemblance to Folsom technology. This point appears to correspond with the eastern Folsom type described by Munson (1990) and the Sedgwick type in northeast Arkansas (Gillam 1996; Morse and Morse 1983). Folsom or Folsom-like points are relatively rare in Missouri (Chapman 1975). O'Brien and Wood (1998:68) credit only four specimens confined to the prairie areas surrounding the Ozarks. Nevertheless, it appears that Folsom artifacts have also been recovered from the western Ozarks. According to Don Dickson (personal communication 1998), one classic Folsom point (Figure 8.50a) and another Folsom-like point (Figure 8.50b) were found by private collectors in western Stone County and south-central Barry County, southwest Missouri.

Perhaps the key to differentiating between Early Paleoindian (Clovis) and Middle Paleoindian (Gainey, Eastern Folsom/Sedgwick) points in the Midwest is fluting technology, as opposed to attributes such as straight vs. convex-sided stems and shallow vs. deeply concave bases. As aptly demonstrated by the eight fluted points found in direct association with a single mammoth at the Naco site,

which presumably are affiliated with a single band (Haynes 1982:385–386, Figure 2), there can be considerable variation in stem and base form as well as size, although size variation may be predominantly due to resharpening. Fluting, however, is remarkably consistent (i.e., relatively thin, shallow flutes) on all eight specimens. Fluting is a difficult technology likely to be taught from one generation to the next. Subtle variations in shape are less important in weapon hafting and function and may be more a reflection of individuality or variability during manufacture.

Fluting on most Clovis (Early Paleoindian) points is minimal, with flute scars rarely exceeding one-half (often only one-third) of the original length of the point (Justice 1987; Wormington 1957). In addition, some Clovis points are fluted on one side only. For example, the three complete Clovis points from the Kimmswick site all exhibit relatively short, narrow flutes (Graham et al. 1981). Most of the Clovis points from the Martens site are similarly fluted (J. Morrow 1996; O'Brien and Wood 1998). In contrast, fluting during Middle Paleoindian times appears to have become more specialized, efficient, and technologically complicated with broader flutes extending well beyond the midpoint, usually on both faces. Examples of full facially fluted points, which are generally considered Middle Paleoindian, are Folsom points in the West and Midwest (Munson 1990; Wormington 1957), and Gainey, Cumberland, Sedgwick/Redstone in the Midwest and East (Gillam 1996; Justice 1987; Roosa and Deller 1982; Simons et al. 1984). Gainey and Cumberland points are generally found east of the Mississippi River with the closest reported Gainey site (Bostrom) in southwest Illinois (Tankersley et al. 1993). Folsom, Folsom-like, and Sedgwick, however, are found in northern and western Missouri and surrounding states (Gillam 1996; Morse and Morse 1983; Munson 1990). Hereafter, Folsom-like points found in Missouri and other areas east of the Great Plains are referred to as Eastern Folsom/Sedgwick.

Assuming that fluting technology is an accurate measure of different point styles and cultural traditions, at least three of the fluted points from the Big Eddy site can be differentiated: the refit specimen excavated from Block C (Figure 8.48d) and the two fluted specimens in the Dan Long collection (Figure 8.48a-b). Each of these exhibits a single, long, central flute scar on both faces, except for the preform failure, which broke prior to striking the second flute. This impressive fluting technology is better developed than that generally found on Clovis points in the Midwest, and therefore, is probably Middle Paleoindian. There even appears to be a difference among the three full facially fluted points. The excavated specimen (Figure 8.48d) and especially the preform failure (Figure 8.48a) are considerably larger and thicker than Folsom and Eastern Folsom/Sedgwick points and are tentatively classified as Gainey. The delicate, waferthin specimen (Figure 8.48b), on the other hand, more closely resembles Folsom technology and is classified as Eastern Folsom/Sedgwick. Although it cannot be demonstrated with the limited evidence at hand, it is entirely possible that two separate Middle Paleoindian components are represented at the Big Eddy site, which is located on a major environmental ecotone: Eastern Folsom/Sedgwick with origins in and ties to the Plains area to the west and Gainey with origins in and ties to the woodland area to the east. It is during Middle Paleoindian times when subregional cultural traditions are recognizable (Anderson 1995b). The fourth and fifth fluted points from the Big Eddy site (Figure 8.48c, e) are too fragmentary to classify as to specific type. Although too thick for Eastern Folsum/Sedgwick, they could represent either Clovis or Gainey. A much larger sample of fluted points, however, needs to be recovered from the Big Eddy site before the above postulated Early and/or Middle Paleoindian components can be confirmed.

Other Lithics

Although no ground-stone tools were recovered from the Early/Middle Paleoindian deposits, several other lithic types were found (Table 8.2). The most abundant type was chert shatter (n=34), which may or may not be a result of knapping activity. A few fragments of fire-cracked rock were recovered, suggesting that one or more hearths may have been associated with the Early/Middle Paleoindian occupation. Three very small fragments of hematite (0.01–0.05 g) from Levels 33 and 34 indicate that red ochre pigment was also being processed at the site. Finally, a few unmodified items of various raw materials are indicative of manuport activities.

Faunal Material

One small bone fragment was recovered from Level 35 between 345 and 350 cm bs. The specimen is calcined, highly weathered, and in very poor condition. This bone was assessed as a fragment from an indeterminate medium to large mammal (Appendix 2).

Radiocarbon Ages

A total of eight radiocarbon dates (six AMS and two bulk carbon) were obtained from Early/Middle Paleoindian levels between 326 and 350 cm bs (see Table 7.1). A ninth sample (AA-27485) obtained from a transitional depth (321–322 cm bs) also appears to be related. Unfortunately, there appears to be little stratigraphic order among the dates (see Chapter 7). Six dates appear to be temporally affiliated with Early Paleoindian (ca. 11,500–10,900 B.P.), and one (AA-26654) is Middle Paleoindian (ca. 10,900–10,500 B.P.) in age.

Due to the recovery of only one diagnostic projectile point in situ and other considerations, the artifact-bearing strata below Late Paleoindian were combined into Early/Middle Paleoindian for all artifact analyses. Nevertheless, a division between Middle Paleoindian and Early Paleoindian strata can be proposed for future scrutiny. It is suggested that Middle Paleoindian deposits extend from the base of the 3Ab horizon (ca. 321 cm bs) to approximately 336 cm bs, which is inclusive of the Gainey point found at 330–331 cm bs. Early Paleoindian deposits are extrapolated to begin at approximately 337 cm bs and extend to approximately 370 cm bs.

Summary and Conclusion

The Early/Middle Paleoindian component appears to represent relatively ephemeral or short-term occupations by at least two temporally distinct groups. Because the site was situated in a setting vulnerable to flooding (i.e., a floodplain), it was probably inhabited primarily during the dry season. The site served as both a lithic-resource procurement station and habitation area. Broken preforms and reduction debitage indicate biface retooling, concentrating on one of the highest-quality resources in the Ozarks—Ellipsoidal Jefferson City chert (see Chapter 9). A variety of domestic activities are also represented at the site, including hunting/butchering (projectile points/knives), various cutting/scraping/engraving activities (utilized flakes/blades, end scraper, and graver), and pigment processing (hematite).

Preliminary interpretations, supported by a suite of radiocarbon assays, have divided diagnostic artifacts into Middle Paleoindian and Early Paleoindian. Unfortunately, only one diagnostic projectile point/knife (refit) was found in excavated context. Based on its size and long, symmetrical, full-facial flutes, it has been classified as a Gainey point. Found on an apparent living surface 10–11 cm below the base of the Dalton horizon, it appears to be Middle Paleoindian. No undisturbed Middle Paleoindian horizon had been previously identified in Missouri or the entire Ozark province. Three radiocarbon dates were obtained within 3 cm vertically of the in situ Gainey point (see Table 7.1). Two of these dates (10,260 ± 85 B.P. [AA-25778] and 11,900 ± 80 B.P. [AA-27486]), however, are inconsistent with the other six dates from the Early/Middle Paleoindian levels. The 10,710 ± 85 B.P. (AA-26654) date, obtained from a charcoal fragment found in the same unit only 2 cm below the in situ Gainey point, is compatible with expectations of Middle Paleoindian deposits. It is believed, therefore, that the date can be directly associated with the excavated Gainey point. This appears to be the first association of a radiocarbon age with the Gainey point type in midcontinental North America.

Two other full facially fluted points recovered from cutbank contexts also appear to be associated with Middle Paleoindian fluting technology. Differences in size, shape, and thickness, however, suggest one is Gainey and the other is Eastern Folsom/Sedgwick. Close temporal and technological connections between Gainey and early Dalton points are indicated by stratigraphic proximity and similar morphologies (straight-sided, concave-based lanceolates). Fluting overlaps only slightly with Dalton, however, quickly giving way to basal thinning as terminal Pleistocene knappers adapted technologies and tool functions to a rapidly changing environment.

An Early Paleoindian or Clovis component is suggested by several radiocarbon dates and a continuation of artifacts well below extrapolated Middle Paleoindian deposits. Most of the radiocarbon dates cluster between 10,950 and 11,400 B.P., suggesting that the Early Paleoindian occupation may have occurred over a slightly longer time span than the Middle Paleoindian occupation. Prior to the Big Eddy investigations, no radiometric assays had

been obtained from Clovis deposits in Missouri. Indeed, the suite of radiocarbon dates from the Big Eddy site makes it one of very few well-dated, stratified Early/Middle Paleoindian sites in eastern North America (Anderson 1995b:149; Ellis et al. 1998; Haynes 1993:223).

The discovery of Early/Middle Paleoindian deposits stratigraphically distinct from overlying Dalton and San Patrice components appears to be unprecedented in in the Midwest. Based on the recovery of three fluted lanceolate points, Kay (personal communication 1998) believes undisturbed Early Paleoindian deposits were also encountered at Rodgers Shelter (Ray et al. 1998:74); however, this interpretation is controversial. As O'Brien and Wood (1998:85) point out, Kay's "fluted points" actually exhibit basal thinning or short flute scars (on one or two faces), both of which are typical attributes of early Dalton points. Recent examination of the Rodgers Shelter specimens at the Illinois State Museum (Figure 8.38) support this observation. Only one specimen, Figure 8.38e (Kay 1982e:498, Figure 11.32j), which was fluted on one face, appears reminiscent of Clovis. However, even this specimen can be considered within the range of variability of early lanceolate-shaped Dalton points. Regardless, this late Clovis or early Dalton point was recovered from a disturbed Middle-Early Archaic context within the shelter area (Kay 1982e:497). The best preserved, deepest strata at Rodgers Shelter actually were represented in the alluvial deposits in front of the shelter overhang (Ahler 1976; Bruce McMillan, personal communication 1998; O'Brien and Wood 1998:79). It was this area that produced the earliest radiocarbon dates (10,200 ± 330 and 10,530 ± 650), which most investigators now consider Late Paleoindian or early Dalton (Goodyear 1982; O'Brien and Wood 1998).

PRE-CLOVIS HORIZON

As indicated above, 370 cm bs is considered a tentative boundary between the Clovis component and a possible pre-Clovis horizon. Due to time constraints, most of the hand excavations in Blocks B and C were terminated at 350 cm bs; however, four test units were hastily dug well below 350 cm bs to probe for earlier deposits. Of these test units, TU 24, barely penetrated below the 3Ab horizon due to the strongly dipping T1c stream bank (Figure 8.19). TU 16 yielded no in situ artifacts below 350 cm, and the deepest undisturbed artifact from TU 4 was found in Level 36 (350–360 cm bs). Test Unit 25, however, contained a sparse scatter of artifacts and manuports to a depth of 390 cm. A dense concentration of angular Burlington chert fragments found over a 30-x-30-cm area at 366–376 cm bs represents the disintegration of one large boulder along incipient fracture planes. This large nodule of residual (angular) Burlington chert was clearly manuported onto the site. Level 38 also produced one in situ flake, one flake associated with a rodent burrow or root cast, and at least three large manuports found at 365–377 cm bs. The largest manuport, which weighs 4.2 kg and measures 20.2 cm long x 17.8 cm wide x 12.0 cm thick, is an unabraded boulder of Warner conglomerate (Figure 8.51). The closest source for this material is in the uplands approximately 0.8 km to the east. This large, nonalluvial cobble of nonlocal Warner conglomerate was also manuported onto the site.

Level 39 (380–390 cm bs) yielded three flakes directly above a thick natural bed of alluvial gravel. These flakes, which exhibit sharp, unabraded edges, were not alluvially deposited or directly associated with the alluvial gravel. Only one flake, however, appeared to have been found in undisturbed context; the other two flakes were associated with a dark stain interpreted as a rodent or root disturbance. The gravel deposit extends across a large portion of Blocks B and C at approximately 380–410 cm bs based on several hand-auger probes and its presence in TU 16, TU 25, and the northern three-quarters of the exploratory trench in Block B. Similar gravel deposits were also noted at about the same depth in the north and south walls of Trench 2, approximately 30 m to the north. The gravel deposit in Blocks B-C varied in thickness from 12–20 cm and exhibited a westward dip, especially in TU 25, which is situated on the edge of the early submember stream bank. Approximately 80% of the gravel was smaller than 3 cm^3 with the largest cobbles approximately 8–10 cm^3. This 12–20-cm-thick gravel bed has effectively sealed any potential cultural deposits located below approximately 390 cm bs, except in the vicinity of isolated bioturbation features. A small piece of wood charcoal found at 384 cm bs at the top of the gravel bed yielded a date of 11,910 ± 440 (AA-27483). Below the gravel bed, several small fragments of charcoal were recovered from 396–412 cm bs. Three of these small fragments were submitted for radiocarbon analyses (see Table 7.1). Two yielded dates of 12,700 ± 180 B.P. (AA-27484) and 12,940 ± 120 B.P.

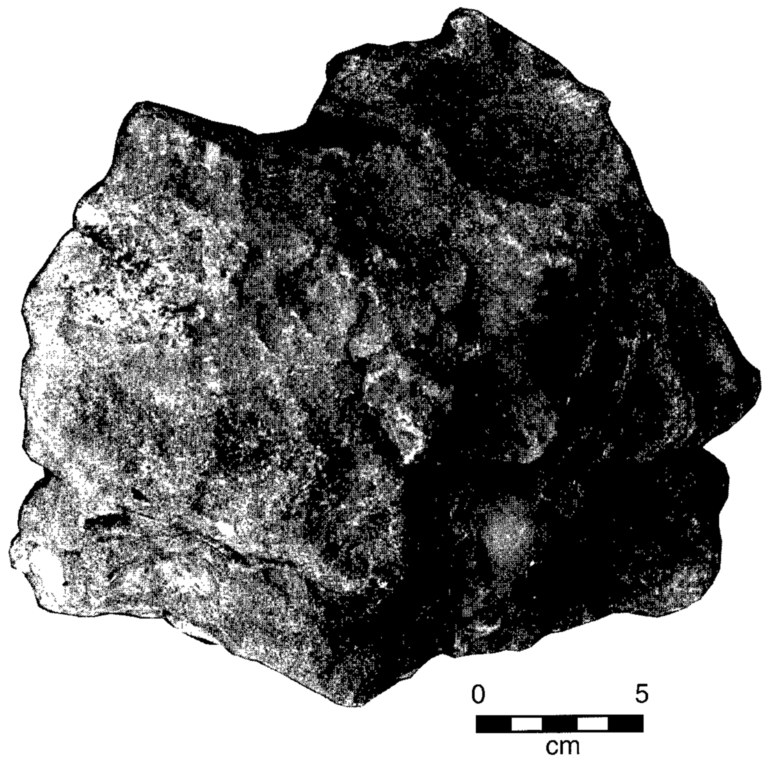


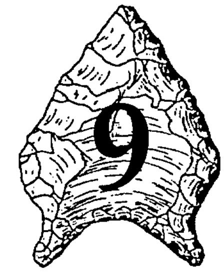
Figure 8.51. Warner conglomerate boulder found at a depth of 365–377 cm bs.

(Beta-109008), whereas the third was 10,680 ± 60 B.P. (AA-29021). The latter date is out of stratigraphic position in comparison to the other two dates and several dates obtained from overlying Early/Middle Paleoindian deposits. At least two krotovina features were noted above, within, and below the gravel deposit as Levels 39–42 (380–420 cm bs) were excavated in TU 25. The small charcoal fragment that yielded the aberrant date of 10,680 ± 60 B.P. was apparently displaced downward via one of the bioturbation conduits through the gravel bed.

In addition to the deeply buried artifacts and manuports found above the gravel bed in TU 25, a problematic flake was found on top of the same gravel bed in TU 16 at a depth of 380 cm. Based on slightly corraded edges and stream-polished surfaces, this flake was redeposited from some location upstream, although probably not far away. The flake is 2.5 cm long, 1.2 cm wide, and 0.5 cm thick, and exhibits a prominent bulb of percussion and two overlapping flake scars on the dorsal side. Based on these attributes, it is tentatively interpreted as a cultural artifact that was redeposited on top of the gravel bed. According to the AMS date from the top of the gravel bar in TU 25, this would have been approximately 12,000 years ago. This implies that a pre-Clovis occupation was nearby in the Sac River valley during or shortly after the gravel bar was deposited.

Based on the above artifacts, manuports, and radiocarbon dates, it appears there is a good possibility that pre-Clovis materials exist at the Big Eddy site just above and below the gravel bed (approximately 380–420+ cm bs). Except for a few localized bioturbated areas, this gravel bed acts as an effective barrier against component mixing. It also appears likely that pre-Clovis horizons exist at other deeply buried locations in the Sac River valley. Future intensive excavations below 370 cm bs can help resolve the question of whether pre-Clovis deposits are present at the Big Eddy site.

CHERT RESOURCE AVAILABILITY AND UTILIZATION



Jack H. Ray

This chapter focuses on the availability, procurement, and use of chipped-stone resources at the Big Eddy site. All locally available chert resources are described and their availability discussed. This is followed by analyses of chipped-stone artifacts recovered during the site investigations and by private collectors. The primary goals of the lithic analyses were to determine various procurement strategies, selection or preference of available raw materials, and heat-treatment practices.

CHIPPED-STONE RESOURCES

The following discussion focuses on those rock formations in the project area that contain chert resources potentially available to prehistoric knappers for the manufacture of chipped-stone tools. From oldest to youngest, these rock units are Jefferson City–Cotter, Chouteau, Burlington-Keokuk, and Warner. Each of these formations and their inclusive lithic resources is described below according to age.

Jefferson City Chert

Geological Context

The Ordovician-aged Jefferson City Formation consists of a light brown to brown finely crystalline dolomite or argillaceous dolomite with localized beds and lenses of shale, sandstone, orthoquartzite, and chert (Knight and Hayes 1961:23; Thompson 1991:39). The contact with overlying Cotter dolomite is very difficult to determine in most areas due to very similar lithologies (Knight and Hayes 1961:23–24; Thompson 1991:41). Jefferson City and Cotter stratigraphic units each average approximately 61 m thick in southwest Missouri (Knight and Hayes 1961:23–24). Inclusive chert deposits from the two units are indistinguishable because of overlapping macro- and microscopic attributes. For this reason, the term Jefferson City chert is used to refer to chert from both units in this report (Ray 1984:233).

Description

Jefferson City chert occurs in thin (1–5 cm) discontinuous bands, continuous beds up to 20 cm thick, large cryptalgal masses up to 70 cm thick, and in nodular form. The nodular chert may be lenticular or elliptical (up to 7 cm thick) and round or irregularly shaped measuring up to 25 cm in diameter. Chert may be sparsely scattered in the bedrock matrix, or in localized areas it may comprise approximately 20% of the rock formation. The cortex on Jefferson City chert is usually very thin (<1 mm), light colored, and smooth (elliptical nodules) to irregularly (cabbage-head nodules) textured. The structure of the matrix of Jefferson City chert nodules may be banded, mottled, oolitic, quartzitic, conglomeritic, or homogeneous. Jefferson City chert is highly variable in color. The most common colors are white (N 8/0; N 9/0; 10YR 8/1), light gray (N 7/0; 7.5YR 7/1; 10YR 7/2), gray (N 5/0; N 6/0; 10YR 5/1, 6/1), dark gray (N 4/0; 7.5YR 4/1), light brownish gray (5YR 6/1; 2.5Y 6/2), brown (7.5YR 4/3, 5/2), bluish gray (5B 5/1, 6/1; 5PB 6/1; 10B 6/1), and pinkish gray (5YR 6/2; 7.5YR 6/2, 7/2), but other observed colors include very dark gray (N 3/0), brownish gray (5YR 4/1), dark bluish gray (5B 4/1), reddish gray (2.5YR 6/1), pale brown (10YR 6/3), very pale brown (10YR 8/2), light yel-

lowish brown (2.5Y 6/4), reddish brown (5YR 5/3), pale red (10R 7/2), moderate red (5R 5/4), light red (10R 6/6), and pale yellow (2.5Y 7/3).

The luster of Jefferson City chert is generally medium but ranges from low to high. The chert can exhibit a number of inclusions, the more common of which are incipient fracture planes, vugs often lined with chalcedony and quartz crystals (druse), oolites, sand grains, and patches of quartzose (coarse deposits of saccharoidal quartz). Less common inclusions are chalcedony or calcite-filled fractures, small pockets of chalk, and rhomboidal voids. Siliceous oolites, commonly found in Jefferson City chert, should not be mistaken for small, round fossils. Fossils are usually very scarce in Jefferson City chert (Ray 1984:234). The only macrofossils reported are gastropods (Beveridge 1951:27; Ray 1981:16). Knight and Hayes (1961:23) state that siliceous (sponge) spicules have been found in insoluble residues, but they are rarely evident in field samples. Fossils common in Mississippian cherts (e.g., crinoids, bryozoa, and brachiopods) are totally absent in Jefferson City chert (Ray 1983:116), which is an important aid in differentiating Jefferson City chert from younger Mississippian cherts in the project area. Jefferson City chert varies in texture and knapping quality. In Cedar County, most is fine grained (often glass-like) and exhibits excellent knapping quality; however, some is coarse grained with deleterious inclusions (Ray 1984:234). The best-quality Jefferson City chert is generally found in nodular forms, especially ellipsoidal nodules.

In the Sac River valley, Jefferson City chert occurs in six distinguishable varieties (oolitic, quartzitic, conglomeritic, banded, mottled, and ellipsoidal); however, a single nodule may contain attributes of two or more varieties and gradation from one variety to another is typical (Ray 1998). This gradation from one variety to another poses some difficulties in differentiating certain varieties of Jefferson City chert, particularly when artifact specimens are small. Conglomeritic, quartzitic, and oolitic are the most distinctive varieties and are relatively easy to differentiate. The ellipsoidal variety is generally distinctive, especially in nodular form; however, some ellipsoidal nodules share attributes with the banded and mottled varieties. The banded and mottled varieties are the least distinctive. This is due primarily to the fact that the mottled variety usually exhibits a "swirled pattern or disturbed banded appearance" (Ray 1981:16), as opposed to the blotchy or spotted mottling of other Ozark cherts. In some regions of the Ozarks, the banded and mottled varieties might be more appropriately combined into a banded-mottled variety. Nevertheless, the majority of each variety can be distinguished in the project area, and in this report, those artifacts that exhibited attributes of both varieties were typed by the dominant attribute.

Oolitic Jefferson City chert is a common variety that generally occurs in bedded form. Individual oolites (small accretionary bodies) are round, elongated, or unstructured. The oolites vary from small to large (average diameters of 0.2–2.0 mm) and may be sand centered, concentrically banded, solid colored, or gray with white rinds. Oolites may be densely or sparsely scattered in the matrix, and they may be of similar size or different sizes. Some Oolitic Jefferson City chert contains small percentages of translucent sand grains. When sand grains comprise approximately 10–50% of the matrix, it is called *Quartzitic Jefferson City* chert. Quartzitic chert, in turn, is transitional to quartzite (i.e., 50% or more sand grains). Fractures generally pass through the sand grains in Quartzitic Jefferson City chert, creating a sparkling affect in direct light. *Conglomeritic Jefferson City* chert is a relatively rare variety. It is similar to the mottled variety but close inspection reveals that the apparent mottles are actually rounded to subangular pebbles cemented in a light gray matrix. The pebbles are generally small (5–15 mm), although occasionally there are much larger pebbles.

Banded Jefferson City chert is commonly found as lenticular and round nodules that are often concentric in cross-section. The bands are usually white alternating with blue, brown, or gray. Banded Jefferson City chert often grades into Mottled and Oolitic varieties. *Mottled Jefferson City* chert commonly occurs as irregular cabbage-head nodules; the mottling may be a combination of any of the dominant colors. Mottled Jefferson City chert is different from mottled Mississippian cherts in that it usually exhibits a swirled pattern or disturbed banded appearance rather than blotches or spots (Ray 1983:114). The Mottled variety often grades into Oolitic and Banded varieties. *Ellipsoidal Jefferson City* chert occurs in relatively flat, elongated, ellipsoidal nodules that are very fine grained and usually free of internal flaws. As a result, the ellipsoidal variety generally exhibits good to excellent knapping qualities. It occurs in monotonal colors such as white, light and dark gray, brownish gray,

purplish gray, and greenish gray, but often grades into a banding of light and dark colors.

In the Sac River valley, oolites constitute a diagnostic trait distinguishing Jefferson City chert from nonoolitic Mississippian cherts. Although not diagnostic, banding is also distinctive of Jefferson City chert since Mississippian cherts are rarely banded. In addition to oolites and banding, the absence of fossils and presence of dark (blue-gray) colors help differentiate Jefferson City chert from younger Mississippian cherts (Ray 1983:114–116). In southwest Missouri, light-colored Jefferson City chert can be easily confused with light-colored and sparsely fossiliferous Mississippian cherts. In general, though, light-colored Jefferson City chert exhibits a much higher luster than the more matte Mississippian cherts.

Jefferson City Quartzite

Geologic Context

Although not as abundant or widespread as chert, localized deposits of quartzite also occur in the Jefferson City–Cotter Formation (Ray 1984:233). Technically, Jefferson City quartzite is an orthoquartzite (or sedimentary quartzite) since it has not been metamorphosed. However, much of it is so well cemented that it appears identical to metamorphosed quartzites in the Appalachian and Rocky Mountain areas. Thus, for simplicity, it is referred to here as simply quartzite. The geologic context is the same as that for Jefferson City chert except that Jefferson City quartzite occurs only in continuous beds and discontinuous lenses that may intergrade with chert deposits (Ray 1998).

Description

The cortex of Jefferson City quartzite is very thin and usually white to light gray. The matrix is usually white (N 9/0; N 8/0; 7.5YR 8/1), light gray (N 7/0; 10YR 7/2), gray (N 6/0; 7.5YR 5/1), or light brownish gray (10YR6/2), but may be light yellowish brown (2.5Y 6/4), brown (7.5YR 5/2), pink (7.5YR 8/3), or pinkish white (10R 8/2). The quartzite may be a single color, slightly mottled, or lightly banded. Transition from quartzite to chert is not uncommon with transition zones varying from abrupt to gradual. Jefferson City quartzite consists of rounded to subrounded, fine to coarse sand grains cemented by white silica. Luster is medium to high. No fossils have been identified in Jefferson City quartzite.

Inclusions in Jefferson City quartzite consist of isolated rounded fragments of chert and oolites and an occasional vug. The quartzite is usually coarse grained, but highly cemented chunks grade to medium. The knapping quality of Jefferson City quartzite is dependent on degree of cementation, which varies from poor to good. It is extremely difficult to distinguish Jefferson City quartzite from Roubidoux quartzite found in the Salem Plateau area to the east (Ray 1984:233). In general, however, sand grains in Jefferson City quartzite are not as densely packed or tightly cemented as Roubidoux quartzite, and weak banding and dark colors are more characteristic of Jefferson City quartzite.

Chouteau Chert

Geologic Context

In southwest Missouri, Chouteau chert is derived from two Mississippian-aged limestone units in the Chouteau group (Spreng 1961:54–57). The two chert-bearing units are the Compton, a finely crinoidal limestone, and the Sedalia, a finely crystalline dolomitic limestone. Chert tends to be much more abundant in the Sedalia unit (up to 30%), but chert can also be found in the Compton unit. Because chert from the two formations is very similar in appearance and difficult to differentiate (Beveridge 1951:32; Spreng 1961:56–57), the term Chouteau is used in an unrestricted sense to refer to chert from either formation (Ray 1981, 1983). Chouteau strata attain a maximum thickness of about 30 m in western Missouri (Spreng 1961:54–57).

Description

Chouteau chert occurs in large, lenticular, subrectangular or tabular nodules up to 25 cm long and 10 cm thick that tend to stratify along bedding planes into continuous beds. The cortex is white or light gray and prominent, typically 10 mm thick. Often a light-colored rind just beneath the cortex will encompass a darker-colored matrix. The matrix of Chouteau chert includes the following colors: light gray (N 7/0; 10YR 7/1; 2.5Y 7/1), gray (N 5/0; N 6/0; 10YR 5/1; 2.5Y 6/1), dark gray (N 4/0; 10YR 4/1; 2.5Y 4/1), very dark gray (N 3), and occasionally bluish black (10B 2.5/1). The matrix of Chouteau chert may be a solid color or light gray to

gray with dark gray mottles. The mottling is generally expressed as irregular blotches or spots, but some mottling exhibits small, oval-shaped structures. On rare occasion the matrix may exhibit faint banding.

The luster of Chouteau chert varies from low to high with the majority exhibiting a medium waxy luster. The chert in Cedar, St. Clair, Hickory, Benton, and southern Pettis counties tends to exhibit a higher sheen on average than that found to the north in northern Pettis, Saline, and Cooper counties. Chouteau chert is moderately fossiliferous; it contains bryozoa, crinoids, siliceous spicules, gastropods, and brachiopods (Ray 1983:116). Compared to Burlington chert, Chouteau chert generally contains a much higher percentage of bryozoan fossils. Bryozoan and other fossil fragments frequently appear as minute, nearly microscopic white specks in a gray matrix. Chouteau chert is commonly plagued by numerous incipient fracture planes. Because of these fracture planes, much of the chert is brittle and is easily shattered when knapped. Texture grades from coarse to fine with the majority being medium. Knapping quality is highly variable; much of it is poor to fair due to incipient fracture planes, but localized deposits in St. Clair and Cedar counties contain fracture-free nodules of good to excellent quality (Ray 1981:77). Chouteau chert is not as common as other local chert types, but it is not difficult to find wherever it outcrops. There is no single trait that is diagnostic of Chouteau chert; however, coloration, characteristic mottled patterning, and fossil size and content combine to differentiate it from Burlington chert. Perhaps the best distinction between these two Mississippian cherts is that small fossil fragments in Chouteau chert are often replaced by distinctive white (N 9/0) silica. Although most Chouteau chert would not be confused with other types, some light-colored Lower Reeds Spring chert exhibits a mottling of light and dark gray colors very similar to Chouteau (Ray 1985). In addition, some Chouteau chert with small, dark, oval mottles mimics Middle Reeds Spring chert (Ray 1998).

Burlington Chert

Geological Context

Burlington chert is derived from a coarsely crystalline to highly fossiliferous crinoidal Burlington limestone and an overlying lithologically similar Keokuk limestone. In areas where the two limestones are coterminous, most geologists combine the two units into a single Burlington-Keokuk Formation since the boundary is transitional and often difficult or impossible to identify (Spreng 1961:64–65; Thompson 1986:92). Like the encompassing limestones, the cherts from each unit overlap in characteristics and are often identical. As a result, the term Burlington has been used in Missouri (Ray 1984:243) in an unrestricted sense to refer to any chert from the Burlington-Keokuk unit. Burlington limestone varies from 30.5–45.8 m (100–150 ft) thick, while Keokuk limestone is typically 15.3–24.4 m (50–80 ft) thick (Spreng 1961). Although chert is potentially present throughout the formation, it is usually most abundant in the lower and upper parts of the Burlington and Keokuk limestones. In some of the cherty zones, chert comprises up to 50% of this Mississippian-aged rock formation.

Description

Chert in the Burlington-Keokuk Formation occurs in small and large rounded to elongated nodules up to 20 cm thick and in discontinuous and continuous beds 30 cm or more thick. The chert typically exhibits a thin, smooth to irregular cortex that is white, light gray, or light brown; however, it is also often oxidized reddish brown. Burlington chert is generally white (N 9; 7.5YR 8/1; 10YR 8/1; 2.5Y 8/1) to light gray (N 7; 5YR 7/1; 10YR 7/1, 7/2) with occasional gray (10YR 6/1) and brown (7.5YR 5/2) mottling. Mottled chert is more common in the upper portion of the formation, especially in Keokuk strata. Banding is very rare in Burlington chert (Ray 1983:121). In raw form, Burlington chert generally exhibits a low (dull) luster; however, in localized areas high-quality, fine-grained material exhibits a medium luster.

Burlington chert is generally highly fossiliferous, with fossils comprising up to 90% of the chert matrix. The most common fossils are crinoids, which vary in size from small to large (1–8 mm in diameter). These fossils are often two to three times as large as crinoids in Chouteau chert and are usually much more abundant. Occasionally, intact columnal segments of crinoid stems occur in Burlington chert, some of which exhibit voids that were not completely replaced by silica (Ray 1983:121). Other fossils commonly found in Burlington chert include bryozoa (branching and lacy), brachiopods, solitary coral, and spicules. Blastoids and colonial coral are

occasionally seen in the chert, while trilobites are rarely found. Some Burlington chert appears to be sparsely fossiliferous or even nonfossiliferous; however, this is usually the result of fossil obscuration during diagenesis of the chert. Fossils are most difficult to identify in fine-grained chert that is creamy white. Conversely, fossils are most clearly seen in coarse- to medium-grained dark-colored areas. Certain factors reduce the knappability of Burlington chert, including incipient fracture planes and fossil voids (Ray 1984:243). In addition, the matrix of highly weathered cobbles often becomes tripolitic (chalk-like) and difficult to knap. Burlington chert generally exhibits a medium-grained texture, but it frequently grades to coarse and occasionally fine. In its natural state, Burlington chert generally ranges in quality from poor to good, but occasionally excellent material can be found. The knapping quality of medium- and coarse-grained Burlington chert can easily be improved via thermal alteration; the chert often becomes glass-like and exhibits a waxy luster and deep pinkish hues due to iron oxidation.

Warner Chert

Geological Context

The Pennsylvanian-age Warner Formation is usually composed of a chert conglomerate overlain by sandstone deposits (Searight 1961:83). The chert in the conglomerate consists of well-rounded cobbles and boulders cemented by coarse sandstone. Locally, the cherty conglomerate often forms a resistant cap on topographic highs in southwest Missouri (Beveridge 1970:23). The cementing sand deposits quickly weather out, leaving a dense lag of chert rubble. In some areas, the Warner gravels appear in filled sink deposits; however, in most areas the conglomerate occurs in deep channel-fill deposits (Beveridge 1970:22–23). The Warner Formation is generally less than 10 m thick, and it usually rests upon an extensively eroded surface (unconformity) on Mississippian-age strata (Beveridge 1970:23). Redeposited chert cobbles comprise approximately 80–90% of the Warner conglomerate. Unconsolidated deposits of conglomerate mantle local ridges with an abundance of subangular to rounded chert pebbles, cobbles, and boulders. Warner chert is composed primarily of eroded and redeposited Burlington chert with smaller amounts of Mississippian-aged Chouteau, Elsey, and Warsaw cherts. In addition, small quantities of Ordovician-aged Jefferson City chert cobbles have been found in the conglomerate (Ray 1998).

Description

The cortex of unfractured Warner chert ranges from subangular to rounded; however, angular surfaces are common on fractured pieces due to freeze-thaw shattering along incipient fracture planes. Highly rounded cobbles often exhibit polished surfaces and numerous impact cones. Cortexes are usually thin and occur in white, gray, brown, and reddish brown colors. Relict patches of coarse sand still adhere to some cortical surfaces. The matrix colors of Warner chert include red (10R 4/6), dark red (10R 3/6), dusky red (10R 3/3), strong brown (7.5YR 5/6), dark gray (7.5YR 4/1), gray (10YR 6/1), light gray (7.5YR 7/1; 10YR 7/1; 2.5Y 7/2), pinkish gray (7.5YR 7/2), and white (N 9/0, 8/0; 7.5YR 8/1). The colors may be homogeneous or arranged in irregular mottled patterns. Red- and brown-colored cherts, which usually comprise a small but highly visible portion of the conglomeritic chert, are a result of long-term weathering within the ferruginous (iron-rich) sandstone matrix.

The natural luster of Warner chert is usually low. Except for occasional nonfossiliferous Ordovician cobbles, Warner chert is sparsely to highly fossiliferous (predominantly crinoids and bryozoa). Incipient fracture planes are abundant, and some highly weathered cobbles grade to tripolitic. The texture of Warner chert is usually coarse to medium; some medium-textured chert resembles novaculite. Due to numerous incipient fracture planes in most of the cobbles, the knapping quality of Warner chert is generally poor, although a few fair to excellent cobbles can be found. It is very difficult or impossible to differentiate artifacts made from Pennsylvanian-redeposited Burlington chert (i.e., Warner) from primary deposits of Burlington chert unless highly abraded and rounded cortical surfaces are present, or unless the chert is stained with bright red, brown, and yellow colors (Ray 1998).

CHERT-RESOURCE AVAILABILITY

Determining the availability and distribution of various chert resources in and around a project area is crucial to interpretations of prehistoric procurement and use. The identification of local re-

sources vs. extralocal resources enables interpretations of mobility and/or exchange patterns of different prehistoric groups. For such comparisons, it is important to make a distinction between various available resources according to distance from a particular project area.

Three types of lithic resources are generally distinguished: local, nonlocal, and exotic (Ray 1998). For the purposes of this report, a *local* resource refers to raw material that was readily available to a specific location on a daily basis. This roughly equals the distance a knapper could walk in a day divided by two (round trip). Assuming an average walking speed of 1.6 km per hour and 12 hours of daylight divided by two, then any lithic resource located within approximately 10 km of a project area is considered a local resource.

A *nonlocal* resource refers to any raw material that requires more than one day and less than ten days to procure, i.e., more than 10 km and less than 100 km from a site. This generally translates to lithic resources located in counties surrounding a project area. Nonlocal resources are often found in lithic assemblages of a particular study area but generally in relatively minor quantities. An *exotic* resource refers to any raw material located 100 km or more from the project area. Exotic resources could have been obtained directly only through extended expeditions (i.e., more than 10 days travel) via embedded procurement or indirectly via long-distance trade.

Although some nonlocal resources were potentially available, only local and exotic resources were recovered during the 1997 excavations at Big Eddy.

Local Resources

Based on these definitions, five chipped-stone resources (Jefferson City chert, Jefferson City quartzite, Chouteau chert, Burlington chert, and Warner chert) are local to the study area because secondary deposits of each of these are found in gravel bars of the Sac River in the vicinity of the Big Eddy site. The availability and distribution of primary (bedrock and residual) deposits, however, varies significantly, as described below.

A generalized state geologic map (McCracken 1961) indicates that the Jefferson City–Cotter Formation outcrops in four areas within the Sac River basin. These are a section from the Cedar Creek–Sac River confluence to the Sac-Osage River confluence in Cedar and St. Clair counties; a section along the Sac River from just south of Caplinger Mills to the Cedar-Dade county line; a section in the upper Bear Creek valley in western Polk County; and a section in the upper Little Sac River valley in Polk and Greene counties. More detailed geologic mapping (Neill 1987), however, reveals that actual bedrock exposures of Jefferson City–Cotter strata are more localized, especially in the central portion of Cedar County (see Figure 2.2).

There are no bedrock exposures of Jefferson City–Cotter in the immediate vicinity of the Big Eddy site. The closest outcrops occur along the lower portion of Silver Creek 2–3 km to the northeast (downstream), and along the base of a ridge approximately 3.0–3.5 km east-southeast (upstream) of the site (Figure 2.2). Abundant quantities of Ellipsoidal and Banded Jefferson City chert nodules and accompanying workshop debitage (23CE500) were recorded at the latter location. More extensive Jefferson City–Cotter outcrop areas occur in the vicinity of Stockton Dam and Lake approximately 4–6+ km to the southeast and in the valleys of Turkey Creek and Brush Creek 8–12+ km to the northeast. Jefferson City chert can be found at all these locations; however, Jefferson City quartzite is much more localized. The closest bedrock or residual source of Jefferson City quartzite is uncertain, but based on local reconnaissance, it is probably two or three times as distant as primary deposits of Jefferson City chert.

Primary deposits of Chouteau chert can be found over a larger area than Jefferson City chert, and these deposits are closer to the Big Eddy site. Compton and Sedalia strata outcrop primarily along the east side of the Sac River valley from Caplinger Mills to Stockton Dam and beyond (Figure 2.2). The closest potential sources of Chouteau chert are along ridge slopes and intermittent streams draining the uplands approximately 1.4 km or more to the east and northeast. A reconnaissance survey found significant deposits of Chouteau chert and limited workshop debris (23CE501) in a ravine draining the upland only 2.2 km east of the Big Eddy site. Primary deposits of Chouteau chert would probably have been more attractive sources than secondary deposits since Chouteau chert comprises only a minor portion of the local river gravels.

The Burlington-Keokuk Formation is the most expansive of the local chert-bearing formations, outcropping over a broad portion of central Cedar County. It comprises most of the uplands bordering

the west side of the Sac River valley from Stockton Lake to Caplinger Mills, and it caps the ridge tops along the east side of the valley (Figure 2.2). In the immediate site vicinity, bedrock and residual deposits of Burlington chert occur all along the bluff line just across the river. The expansive outcrop area of the Burlington-Keokuk Formation and the large quantities of inclusive chert deposits are the primary reasons why Burlington chert is so prevalent in the gravel deposits of the Sac River.

Deposits of Warner chert conglomerate are more localized compared to Burlington chert. On the west side of the Sac River, it occurs as isolated patches in the uplands with a concentrated deposit at Gravelly Bluff approximately 3 km southeast of the site (Figure 2.2). Pennsylvanian deposits, including Warner conglomerate, are more expansive in the uplands on the east side of the Sac River approximately 4+ km to northeast. The closest residual source of Warner chert conglomerate, however, is an unmapped deposit discovered only 800 m to the east-northeast of the Big Eddy site. This localized deposit appears to be related to or an extension of the fault line associated with the Gravelly Bluff–Stockton graben (Neill 1987). Highly corraded (rounded), small to large cobbles and occasional boulders litter the hill slope at this location.

Exotic Resources

Exotic raw materials account for a very small minority (0.3%) of the chipped-stone artifacts recovered from the Big Eddy site; nevertheless, several exotic chert types are represented at the site. Exotic chert resources can be divided into three groups, two of which can be traced to separate physiographic regions: Mississippian cherts located in the southwestern Ozarks, Pennsylvanian cherts located in the eastern Plains area of western Missouri and eastern Kansas, and unidentified exotic cherts of unknown origin.

The exotic Mississippian cherts are Red Pierson chert, two varieties of Reeds Spring chert (Lower and Middle), and Pitkin chert (Ray 1998). Red Pierson, Lower Reeds Spring, and Middle Reeds Spring cherts only occur south of the Ozark Divide in extreme southwest Missouri, northwest Arkansas, and parts of northeast Oklahoma at a range of 100–200 km from the Big Eddy site. The nearest sources of Red Pierson are in central Barry and Stone counties, Missouri, approximately 110 km south of the Big Eddy site, but the most abundant quantities of Red Pierson chert are further south at 140+ km. The closest source of Lower Reeds Spring chert is in northern Stone County approximately 100 km south of the project area with more abundant sources 120+ km south. The nearest viable sources of Middle Reeds Spring chert are in southwest Christian County, Missouri, approximately 110 km south-southeast with more abundant quantities in southern McDonald County 120+ km south-southwest. Pitkin chert, however, occurs only along the Boston Mountains escarpment in northern Arkansas approximately 200 km south of the site.

At least two exotic Pennsylvanian cherts were identified in the Big Eddy collections: Winterset chert and Florence B chert. Winterset chert (Reid 1980:126) occurs primarily in the greater Kansas City area approximately 240 km northwest of the Big Eddy site; however, outlying deposits occur as far south as northwestern Bates County, Missouri, approximately 110 km to the northwest. Florence B chert occurs in the Flint Hills region of eastern Kansas (Vehik 1984) approximately 250 km west of the project area. At least five unidentified exotic cherts were also found at the Big Eddy site.

Redeposited Cherts and Gravel-Bar Tests

It has long been recognized that systematic examination of stream deposits is important to evaluating prehistoric chert exploitation. Gravel-bar studies have been conducted in several portions of the Midwest to determine raw-material availability, distribution, and abundance (Amick 1981; Gatus 1983; Ray 1982, 1992). In Missouri and Arkansas, Ray (1982, 1992) tested the quantity and quality of stream cobbles to better interpret variability in the abundance and knappability of local chert types. The data obtained were then compared to artifactual data from archaeological sites to ascertain potential preferences and selection among the naturally occurring raw materials.

Similar tests of alluvial cobbles were conducted at three gravel bars along the Sac River to determine the relative quantities and qualities of the five local chert resources in the project area. Gravel-bar Test Sites 1 and 2 are located on the south and west sides of the Big Eddy site, respectively. The gravel deposits on the south side of the site are comprised of paleogravels (i.e., late Pleistocene) underlying the early submember that have been exposed by recent erosion of the cutbank (see Chapter 7). The gravel bar situated on the west side of the site, how-

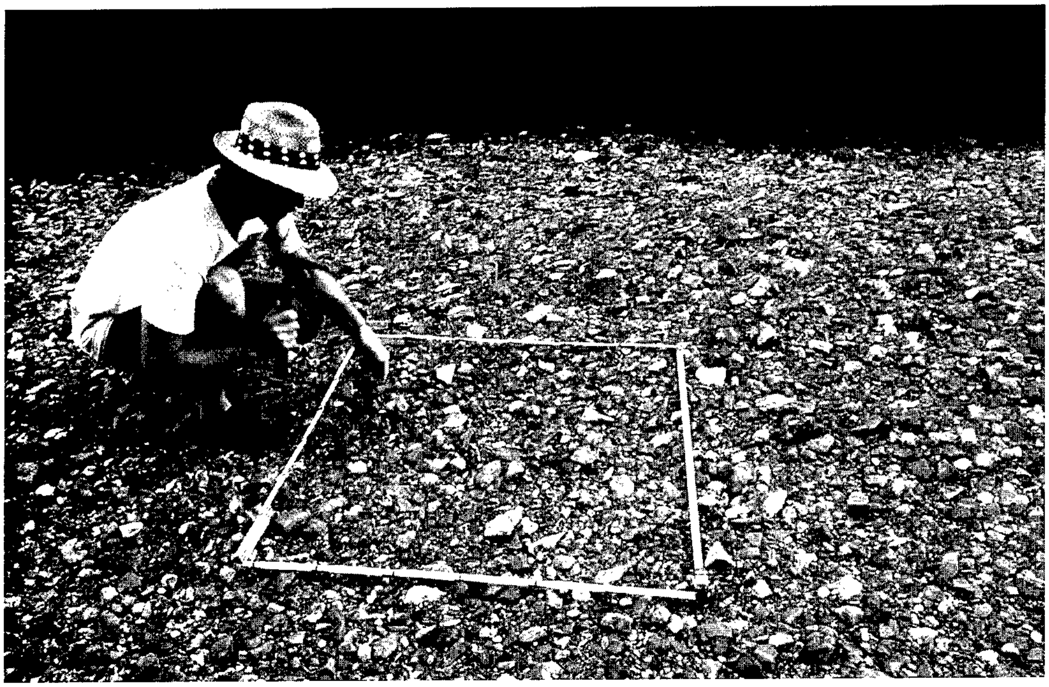


Figure 9.1. Testing alluvial cobbles on gravel bar at west end of Big Eddy site (Test Site 2).

ever, is comprised of reworked deposits that are probably less than 300 years old based on the associated Pippins alluvium, the base of which was radiocarbon dated to 490 ± 50 B.P. (see Table 7.1). Gravel-bar Test Site 3 is located at the confluence of Bear Creek and the Sac River approximately 4.2 km southeast of the Big Eddy site. This gravel bar was tested to determine if the alluvial cobbles in the vicinity of the Montgomery site were comparable to those around the Big Eddy site.

Gravel-bar testing was conducted in a series of 1-x-1-m units at each of the three test sites (Figure 9.1). Only those nodules exposed at the surface of the gravel bar were tested (one nodule deep), and any nodule projecting into the sample unit was included in the inventory. All nodules that had a long axis measuring approximately 6–8 cm or larger and were 2 cm or more thick were sampled. Nodules that measured less than these dimensions were considered too small for use as productive flake-blank or cobble-blank cores. Each eligible nodule was recorded as to rock type and then tested for quality by removing a few flakes by hard-hammer percussion. The quality (or knappability) criteria outlined by Ray (1982) were used in the gravel bar tests (Table 9.1).

Six 1-x-1-m units were sampled at Test Site 1, and the same number was sampled at Test Site 2. The data reveal considerable variability in the quantity and quality of the lithic resources found in the Sac River gravels. In addition to chert cobbles, sandstone, siltstone, quartzite, and limestone nodules are present in the gravel deposits (Table 9.2). Despite the differing ages of the gravel bars (late Pleistocene and recent), the percentages of the various rock types at both are relatively similar. The only significant differences in composition of the two gravel bars are greater percentages of Burlington chert and limestone cobbles (and corresponding decreases in other rock types) at Test Site 2 due to contributions from the Burlington bluff adjacent to that gravel bar. Thus, there appears to be little difference in the composition of Sac River gravel-bar deposits from the late Pleistocene to modern times, and the data from the two test sites are combined in the following discussion.

The total number of cobbles sampled from both test areas (12 m^2) was 364, a density of 30.3 nodules

Table 9.1. Nodule Quality Criteria.

Quality	Criteria
Very poor	Little or no conchoidal fracture, sandy or grainy, extensive inclusions and/or incipient fractures
Poor	Poor conchoidal fracture, coarse grained, full of inclusions and/or incipient fractures, no control over flaking
Fair	Not quite quality material, conchoidal fracture average, medium to coarse grained, some inclusions and/or fracture planes, some control over flaking
Good	Quality material, good conchoidal fracture, medium to fine grained, very few inclusions and/or incipient fractures, control over flaking
Excellent	Pure material with no inclusions or fracture planes, fine grained, choice material, excellent control over flaking

Table 9.2. Gravel-Bar Data.

	South Bar Big Eddy Test Site 1		West Bar Big Eddy Test Site 2		Test Sites 1 and 2: Total		Test Sites 1 and 2: Chert and Quartzite Cobbles Only		Mouth of Bear Creek Test Site 3	
Rock Type	N	%	N	%	N	%	N	%	N	%
Burlington chert	117	74.5	134	64.7	251	69.0	251	82.6	132	66.0
Jefferson City chert (total)	13	8.3	29	14.0	42	11.5	42	13.8	30	15.0
Banded	1	0.6	6	2.9	7	1.9	7	2.3		
Conglomeritic	1	0.6			1	0.3	1	0.3		
Ellipsoidal			5	2.4	5	1.4	5	1.6		
Mottled	6	3.8	8	3.9	14	3.8	14	4.6		
Oolitic	3	1.9	7	3.4	10	2.7	10	3.3		
Quartzitic	2	1.3	3	1.5	5	1.4	5	1.6		
Chouteau chert	1	0.6	2	1.0	3	0.8	3	1.0		
Warner chert			4	1.9	4	1.1	4	1.3	1	0.5
Jefferson City quartzite	2	1.3	2	1.0	4	1.1	4	1.3	3	1.5
Limestone	1	0.6	18	8.7	19	5.2			3	1.5
Sandstone	14	8.9	10	4.8	24	6.6			13	6.5
Siltstone	9	5.7	8	3.9	17	4.7			18	9.0
Total	157	100.0	207	100.0	364	100.0	304	100.0	200	100.0

Table 9.3. Knapping Quality Composite Data.

	Burlington Chert		Jefferson City Chert	
	N	%	N	%
Test Site 1				
Knappable	59	50.4	8	61.5
Unknappable	58	49.6	5	38.5
Total	117	100.0	13	100.0
Test Site 2				
Knappable	85	63.4	23	79.3
Unknappable	49	36.6	6	20.7
Total	134	100.0	29	100.0
Nodule quality—Test Sites 1 and 2				
Knappable				
Excellent	5	2.0	2	4.8
Good	35	13.9	15	35.7
Fair	104	41.4	14	33.3
Total knappable	144	57.4	31	73.8
Unknappable				
Poor	85	33.9	11	26.2
Very poor	22	8.8		
Total unknappable	107	42.6	11	26.2
Total	251	100.0	42	100.0

per m^2. Overall, Burlington chert dominates the Sac River gravels, comprising nearly 70% of all cobbles. Jefferson City chert comprises the secondmost common rock type (11.5%), followed by smaller percentages of sandstone, limestone, siltstone, Warner chert, Jefferson City quartzite, and Chouteau chert. These figures, however, include rocks not suitable for the manufacture of chipped-stone tools; they comprise 16.5% of the nodules tested. If the sandstone, siltstone, and limestone cobbles are excluded from the sample, a more representative quantification of the five chipped-stone resources is apparent. The total number of chert and quartzite nodules tested was 304, a density of 25.3 cobbles per m^2. Revised percentages reveal that approximately 83% of the cobbles are Burlington chert, about 14% are Jefferson City chert, and Jefferson City quartzite, Warner chert, and Chouteau chert each comprise only approximately 1% of the stream gravels (Table 9.2). The dominance of Burlington chert in the gravels is due to the thickness (up to 70 m) and cherty nature of the Burlington-Keokuk Formation and its expansive outcrop area relative to the other chert-bearing units in the drainage basin.

Each eligible cobble in the 1-x-1-m units was tested for quality or knappability by hard-hammer percussion. Cobbles exhibiting excellent, good, and fair knapping qualities are considered knappable, whereas those exhibiting poor or very poor qualities are considered unknappable. Table 9.3 shows the knapping qualities of the two dominant resources at Test Sites 1 and 2 (on the south and west sides of the Big Eddy site, respectively). The data indicate that both Burlington chert and Jefferson City chert are relatively high-quality resources. Jefferson City chert, however, appears to be of a higher quality than Burlington chert (74% vs. 57% knappable, respectively). In addition, of the knappable Burlington cobbles, 72.2% was recorded as fair quality and only 27.8% rated good to excellent, compared to 45.2% fair and 54.8% good to excellent for Jefferson City chert. The primary difference in knapping quality is that, on average, Jefferson City chert exhibits a finer-grained texture and a more

Table 9.4. Visual Identification of Stream-Deposited Chert Cobbles, Test Site 2.

	Correct Identification		Incorrect Identification		Total	
Chert Type	N	%	N	%	N	%
Burlington chert	61	93.8	4	6.2	65	100.0
Jefferson City chert	13	72.2	5	27.8	18	100.0
Limestone	9	100.0			9	100.0
Sandstone	6	100.0			6	100.0
Siltstone	5	100.0			5	100.0
Conglomerate	3	100.0			3	100.0
Total	97	91.5	9	8.5	106	100.0

glass-like conchoidal fracture than Burlington chert.

Although no comparisons of the other three local lithic resources can be made due to small sample sizes, some general observations on knapping quality are offered based on extensive regional sampling of each resource. In the Truman Reservoir area to the north, Chouteau chert generally exhibits relatively poor knapping quality due to abundant incipient fracture planes (Ray 1983:116–119); however, Chouteau chert in Cedar County appears to be much less fractured and exhibits fair to good knapping qualities more often than not. The majority of redeposited Warner chert is of relatively poor quality; however, a minor percentage is high quality. Jefferson City quartzite deposits located north of the Ozark Divide rarely exhibit high knapping quality, but much of it is of fair knapping quality.

At Test Site 3 (mouth of Bear Creek), 4 m^2 of gravel-bar deposits were tested; however, only the relative percentages of chert types were quantified with no quality data recorded. A total of 200 cobbles was tested; they revealed percentages similar to the data from Test Sites 1 and 2 (Table 9.2). Only minor differences are apparent. Burlington chert is still overwhelmingly dominant; however, there is a slight increase in the number of Jefferson City chert cobbles and an apparent absence of Chouteau cobbles. Thus, it appears that the relative percentages of the five local chipped-stone resources in gravel bars are approximately the same from the Bear Creek area near the Montgomery site to the Big Eddy site.

In sum, the gravel-bar test results reveal considerable variability in the quality and quantity of chipped-stone resources in local gravel bars of the Sac River. Burlington chert and Jefferson City chert appear to be the most desirable resources found in alluvial sources. Burlington chert is the most abundant chert resource and is quite knappable, although high-quality Burlington chert is not common. In contrast, Jefferson City chert appears to be the highest quality lithic resource, but it occurs in relatively small quantities. Chouteau chert is also a relatively high-quality resource, but it is found only rarely in the Sac River gravels. Due to the relatively scarce quantities of Jefferson City and Chouteau cherts in alluvial sources, residual deposits of these two resources would appear to have been more attractive to prehistoric knappers. Warner chert and Jefferson City quartzite are the least desirable resources in the project area due to poor qualities and scarce quantities.

A second brief experiment was conducted in conjunction with the above gravel-bar tests of raw-material quantity and quality. This experiment was conducted to determine the accuracy of preselecting or culling stream-deposited raw materials based on visual observations of cortical attributes, i.e., how accurate could an experienced eye select among river cobbles for a particular resource prior to cobble testing. The sample consisted of 106 cobbles from three 1-x-1-m units located on the west gravel bar. Each cobble was visually examined and a guestimate of chert type was recorded prior to hard-hammer testing and chert-type verification (Table 9.4). The author, who has nearly 20 years of experience sampling chert resources in southwest Missouri, was the testee. This experience is considered roughly equivalent to an experienced prehistoric knapper.

As expected, unknappable cobbles such as limestone, sandstone, siltstone, and conglomerate were easily identified with 100% accuracy. Differ-

entiation between chert cobbles, of course, was more difficult. Nevertheless, approximately 94% of Burlington chert cobbles and 72% of Jefferson City chert cobbles were accurately identified. This suggests that an experienced knapper could effectively cull at least three-quarters of the cobbles on a gravel bar by visual observation if he was selectively hunting for a particular high-quality resource such as Ellipsoidal Jefferson City chert. Due to the unique shape of Ellipsoidal cobbles, an even higher accuracy rate of visual culling is probable for this distinctive variety of Jefferson City chert. In fact, all of the misidentifications of Jefferson City chert were in relation to large amorphous cobbles typical of other varieties of Jefferson City chert. This test suggests that although Ellipsoidal Jefferson City chert is relatively rare, comprising less than 2% of the chert cobbles in Sac River gravel deposits (Table 9.2), experienced knappers probably had little problem in finding this high-quality resource by visual inspection of expansive gravel bars. Several independent cursory surveys across gravel bars in the vicinity of the Big Eddy site each yielded a handful of Ellipsoidal Jefferson City chert cobbles in less than ten minutes.

CHERT USE AND SELECTION

Before proceeding to the analyses of the artifactual data, four terms that will be used to characterize the degree of utilization of each lithic resource are defined. A *primary resource* refers to the dominant raw material that was utilized by a particular group of knappers. It is generally locally available and exhibits one or more attractive attributes such as good to excellent knapping qualities, abundance, wide distribution, few inclusive flaws, and large nodular or bedded forms.

A *secondary resource* is supplemental to the primary resource. It generally comprises 10–30% or more of a typical assemblage. A secondary resource may occur in abundant quantities but exhibit relatively poor knapping qualities, or it may occur in low quantities and exhibit relatively high knapping qualities. Although secondary sources were not the focus of prehistoric knappers, the procurement of these resources appears to have been planned or intentional rather than incidental or opportunistic.

A *tertiary resource* is one that comprises more than 1% but less than 10% of a site collection. It occurs in minor quantities but is found on a consistent basis in a research area. The procurement of tertiary resources appears to have been more opportunistic than intentional. In other words, these resources were probably acquired primarily in conjunction with other activities (i.e., via embedded procurement). Tertiary resources may be local or nonlocal in origin. If local, the resource is of relatively poor quality, but if nonlocal the quality is generally higher.

An *incidental resource* occurs in very small quantities (<1%) and on an infrequent basis. It is often nonlocal or exotic to a study area. It typically occurs as an occasional broken, curated tool or as resharpening/rejuvenation flakes knapped from curated tools. If locally available, it was a highly undesirable raw material for the production of chipped-stone tools. It should be pointed out that the terms primary, secondary, tertiary, and incidental are not necessarily applicable to the same lithic resources diachronically. In other words, a certain raw material exploited as the primary resource by one group of knappers may have been a secondary or tertiary resource for another group and vice versa. Differential exploitation often depends on preferences for certain qualities or attributes and/or the practice of thermal alteration.

All chipped-stone artifacts recovered from the Big Eddy site were identified as to raw-material type (Appendix 5). Every prehistoric time period is represented in the data, and most are represented by relatively large sample sizes that reliably reflect prehistoric utilization of local cherts. A few components, however, are represented by relatively small samples. Chert utilization in two periods (Woodland and late Early Archaic), which have sample sizes of 33 and 31, respectively, is considered tentative until more data can be collected. Components represented by fewer than 20 specimens (i.e., late Late Archaic, Middle Archaic, and Pre-Clovis periods) are presented in Table 9.5 but are excluded from Figure 9.2 and discussions of chert utilization. It should also be noted that diagnostic artifacts recovered by private collectors are not included in the component analysis (Table 9.5). Each of these diagnostic artifacts, however, was assigned a time period, and those data were included in Table 9.6 to bolster sample sizes.

The artifact sample used in the following chert analyses is the same as that used for analyses in Chapter 8. That is, the majority of artifacts from the excavations were recovered via careful shovel skimming with a sample portion screened through 0.25-in mesh. A comparison of screened vs. un-

Table 9.5. Chipped-Stone Raw-Material Type by Component.

	Woodland/ Mississippian		Woodland		Woodland/Late Archaic		Late Late Archaic		Middle Late Archaic		Early Late Archaic		Middle Archaic	
Raw Material	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Local														
Warner (Burlington) chert					2	1.5					1	1.5		
Warner (Chouteau) chert									1	0.2				
Burlington chert	81	74.3	18	54.5	96	73.8	6	100.0	591	95.0	51	75.0	10	76.9
Chouteau chert	5	4.6	4	12.1	5	3.8			2	0.3				
Jefferson City chert	23	21.1	10	30.3	27	20.8			28	4.5	15	22.1	3	23.1
Banded variety	2	1.8	3	9.1	9	6.9			5	0.8	6	8.8	1	7.7
Conglomeritic variety														
Ellipsoidal variety	18	16.5	3	9.1	11	8.5			9	1.4	1	1.5		
Mottled variety	2	1.8	2	6.1	5	3.8			10	1.6	4	5.9	2	15.4
Oolitic variety	1	0.9	2	6.1	1	0.8			4	0.6	4	5.9		
Quartzitic variety					1	0.8								
Exotic														
Pitkin chert														
Middle Reeds Spring chert														
Lower Reeds Spring chert											1	1.5		
Red Pierson chert														
Florence B chert			1	3.0										
Winterset chert														
Unidentified chert														
Total	109	100.0	33	100.0	130	100.0	6	100.0	622	100.0	68	100.0	13	100.0

Table 9.5. Chipped-Stone Raw-Material Type by Component. (Continued).

	Late Early Archaic		Early Early Archaic		Late Paleoindian		Early/Middle Paleoindian		Pre-Clovis		Total	
Raw Material	N	%	N	%	N	%	N	%	N	%	N	%
Local												
Warner (Burlington) chert					1	<0.1					4	<0.1
Warner (Chouteau) chert											1	<0.1
Burlington chert	18	56.3	34	9.4	527	5.2	30	5.7	2	40.0	1,464	12.1
Chouteau chert	6	18.8	36	9.9	1,071	10.5	41	7.8			1,170	9.7
Jefferson City chert	8	25.0	289	79.8	8,563	84.0	457	86.4	3	60.0	9,427	77.9
Banded variety	3	9.4	82	22.7	2,721	26.7	90	17.0	1	20.0	2,923	24.1
Conglomeritic variety			2	0.6	29	0.3					31	0.3
Ellipsoidal variety	3	9.4	138	38.1	5,152	50.5	321	60.5	1	20.0	5,656	46.7
Mottled variety	1	3.1	47	13.0	492	4.8	34	6.4	1	20.0	600	5.0
Oolitic variety	1	3.1	12	3.3	116	1.1	10	1.9			151	1.2
Quartzitic variety			8	2.2	54	0.5	3	0.6			66	0.5
Exotic												
Pitkin chert			2	0.6	20	0.2					22	0.2
Middle Reeds Spring chert					1	<0.1					1	<0.1
Lower Reeds Spring chert					3	<0.1					4	<0.1
Red Pierson chert					3	<0.1					3	<0.1
Florence B chert											1	<0.1
Winterset chert					1	<0.1					1	<0.1
Unidentified chert			1	0.3	4	<0.1	1	0.2			6	<0.1
Total	32	100.0	362	100.0	10,195	100.0	529	100.0	5	100.0	12,104	100.0

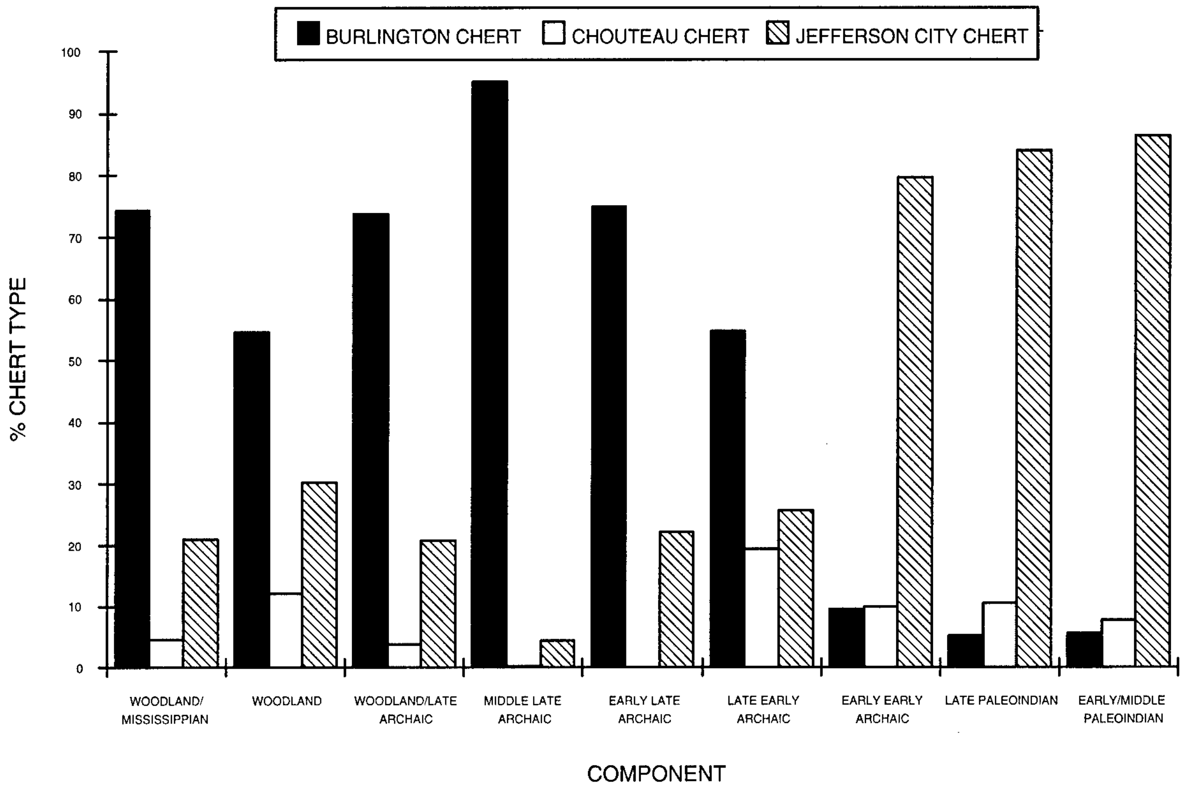


Figure 9.2. Chert use by component.

screened samples revealed no major differences in the percentages of represented chert types or artifact types (see Table 8.5).

As expected, local cherts were the primary chipped-stone resources utilized by every prehistoric group that occupied the Big Eddy site. The high quality and ready availability of three local cherts (Jefferson City, Chouteau, and Burlington) negated any need to import nonlocal or exotic resources for the manufacture of chipped-stone tools. Indeed, it is entirely possible that some nonlocal residents from relatively chert-poor regions may have, on occasion, targeted the bountiful supplies of high-quality cherts in the project area to restock lithic tool kits. It is also clear that the utilization of certain chert types changed significantly through time, reflecting changing preferences for one or more resources, possibly for technological reasons.

The following discussion focuses on Jefferson City, Chouteau, and Burlington cherts. The other two local resources, Warner chert and Jefferson City quartzite, were virtually ignored as lithic resources. This was undoubtedly due to the limited knapping quality and scarce availability of these two raw materials. Warner chert only appears as a tertiary or incidental resource during Woodland/Archaic, Late Archaic, and Late Paleoindian times. These may represent chance finds discovered in river gravel or nearby upland locations and transported to the site as curios due to the highly rounded and polished appearance of Warner chert cobbles. Alternately, Warner chert cobbles may have been collected for use as ground-stone tools (e.g., manos and anvil stones) and later tested and/or reduced for chipped-stone purposes. The only artifact manufactured from Jefferson City quartzite was a Smith Basal Notched point found by a local collector (Table 9.6). Although it may have been procured from local river gravel, it could also represent a curated artifact made in an area to the east or southeast (Salem Plateau area) where quartzite is much more common.

Table 9.6. Diagnostic Chipped-Stone Artifacts by Raw-Material Type.

	Burlington Chert		Chouteau Chert		Jefferson City Chert Banded Variety		Jefferson City Chert Ellipsoidal Variety		Jefferson City Chert Mottled Variety		Jefferson City Chert Oolitic Variety	
Type	N	%	N	%	N	%	N	%	N	%	N	%
Middle Mississippian												
Madison	1	100.0										
Late Woodland/Early Mississippian												
Cupp	1	100.0										
Reeds	1	100.0										
Scallorn	8	66.7	1	8.3			3	25.0				
Unidentifiable arrowpoint	1	50.0									1	50.0
Woodland												
Gary									1	100.0		
Kings	12	66.7	4	22.2	2	11.1						
Lander	1	50.0									1	50.0
Little Sac	1	50.0					1	50.0				
Marcos	1	100.0										
Standlee					1	100.0						
Waubesa												
Unidentifiable ppk	2	100.0										
Late Late Archaic												
Afton	4	100.0										
Castorville	3	100.0										
Middle Late Archaic												
Williams	6	100.0										
Early Late Archaic												
Etley	4	80.0									1	20.0
Smith	7	43.8			3	18.8	1	6.3	1	6.3	2	12.5
Table Rock	1	100.0										
Late Early Archaic												
Graham Cave	3	75.0					1	25.0				
Hidden Valley					1	50.0	1	50.0				
Jakie											1	100.0
Rice Lobed												
Searcy	2	66.7									1	33.3
Early Early Archaic												
Cache River	1	50.0							1	50.0		
Graham Cave												
Packard	2	40.0			1	20.0	1	20.0	1	20.0		
St. Charles-like											1	100.0
Late Paleoindian												
Dalton	2	40.0					1	20.0			1	20.0
Dalton adze			1	50.0			1	50.0				
San Patrice					1	33.3	1	33.3			1	33.3
Wilson												
Early/Middle Paleoindian												
Clovis/Gainey	2	100.0										
Eastern Folsom/Sedgwick							1	100.0				
Gainey	1	50.0										
Total	67	57.8	6	5.2	9	7.8	12	10.3	4	3.4	10	8.6

Table 9.6. Diagnostic Chipped-Stone Artifacts by Raw-Material Type. (Continued).

	Jefferson City Chert Quartzitic Variety		Jefferson City Quartzite		Lower Reeds Spring Chert		Florence Chert		Unidentified Exotic Chert		Total	
Type	N	%	N	%	N	%	N	%	N	%	N	%
Middle Mississippian												
Madison											1	100.0
Late Woodland/Early Mississippian												
Cupp											1	100.0
Reeds											1	100.0
Scallorn											12	100.0
Unidentifiable arrow point											2	100.0
Woodland												
Gary											1	100.0
Kings											18	100.0
Lander											2	100.0
Little Sac											2	100.0
Marcos											1	100.0
Standlee											1	100.0
Waubesa							1	100.0			1	100.0
Unidentifiable ppk											2	100.0
Late Late Archaic												
Afton											4	100.0
Castorville											3	100.0
Middle Late Archaic												
Williams											6	100.0
Early Late Archaic												
Etley											5	100.0
Smith			1	6.3	1	6.3					16	100.0
Table Rock											1	100.0
Late Early Archaic												
Graham Cave											4	100.0
Hidden Valley											2	100.0
Jakie											1	100.0
Rice Lobed	1	100.0									1	100.0
Searcy											3	100.0
Early Early Archaic												
Cache River											2	100.0
Graham Cave									1	100.0	1	100.0
Packard											5	100.0
St. Charles-like											1	100.0
Late Paleoindian												
Dalton					1	20.0					5	100.0
Dalton adze											2	100.0
San Patrice											3	100.0
Wilson									1	100.0	1	100.0
Early/Middle Paleoindian												
Clovis/Gainey											2	100.0
Eastern Folsom/Sedgwick											1	100.0
Gainey					1	50.0					2	100.0
Total	1	0.9	1	0.9	3	2.6	1	0.9	2	1.7	116	100.0

Early/Middle Paleoindian

Local Cherts

There is little doubt that the Early/Middle Paleoindian occupants focused on Jefferson City chert to the near exclusion of other local resources (Table 9.5). In fact, Chouteau and Burlington cherts were exploited only as tertiary resources during this period. Among the various varieties of Jefferson City chert, Ellipsoidal was clearly preferred, comprising approximately 61% of all Early/Middle Paleoindian artifacts. Banded Jefferson City chert was supplemental or secondary to Ellipsoidal, with the Mottled, Oolitic, and Quartzitic varieties comprising relatively minor amounts. Ellipsoidal Jefferson City chert was probably the preferred variety due to its high knapping quality. On average, Ellipsoidal contains the fewest internal flaws of all the varieties of Jefferson City chert. Selection for Ellipsoidal Jefferson City chert must have been intensive since primary deposits occur locally only in small isolated areas, and secondary deposits are relatively scarce. Ellipsoidal Jefferson City chert cobbles, for example, comprise approximately 12% of Jefferson City chert cobbles in the Sac River and only about 1.6% of all chert cobbles in the river (Table 9.2).

Although the sample of fluted points from the site is very small, it is interesting that more Big Eddy fluted points were made from Burlington chert than Jefferson City chert (Table 9.6). This may, however, reflect curation behavior as opposed to on-site fluted-point manufacture from Burlington chert. Early/Middle Paleoindian knappers in the Midwest, and Missouri in particular, clearly had an affinity for Burlington chert (Walthall and Koldehoff 1998). Above-average (in terms of knapping quality) raw Burlington chert is commonly found in areas north and south of the Missouri-Mississippi river confluence, which is at least one reason that Burlington chert was apparently selected for in eastern Missouri during Early/Middle Paleoindian times. Raw (unheated) Burlington chert in southwest Missouri, on the other hand, is usually coarser grained and of lesser knapping quality, although small, localized deposits of fine-grained, high-quality Burlington chert can be found. At least two of the three Big Eddy fluted points made from Burlington chert were knapped from a very high-quality, fine-grained material not commonly found in the project area. It is possible that these two, and possibly all three, points were manufactured elsewhere, transported to the Sac River valley, and subsequently discarded at the Big Eddy site after breakage. This scenario tends to be supported by the general lack of Burlington chert manufacturing debris (5.7%) from Early/Middle Paleoindian deposits at Big Eddy. Of the remaining fluted points from the Big Eddy site, one was made from local Ellipsoidal Jefferson City chert and one was knapped from an exotic chert.

Exotic Cherts

The only exotic chert artifact recovered from the Early/Middle Paleoindian component during the 1997 excavations was one small flake fragment knapped from an unidentified chert. It is gray (7.5YR 6/1) and white (7.5YR 8.1) in color and exhibits siliceous spicules and other unidentified microscopic fossil detritus not found in local cherts.

Although not part of the excavated collection, an additional artifact knapped from exotic chert is noteworthy. It is the fluted (Gainey) preform fragment in the Dan Long collection, which was knapped from Lower Reeds Spring chert. The closest sources of Lower Reeds Spring chert are located in northern Barry, Stone, and Taney counties in southwest Missouri. Pound for pound, Lower Reeds Spring is probably the highest-quality chert in the southern Ozarks (Ray 1984:238). This Gainey specimen broke during lateral thinning after successfully fluting one face. The fact that this Gainey preform, knapped from exotic chert, failed during manufacture at the Big Eddy site has important implications for the procurement and transportation of raw material (i.e., trade vs. embedded or direct procurement and curation). Since the Reeds Spring Gainey specimen was broken during manufacture at the Big Eddy site, it cannot represent a finished curated tool that was made in southwest Missouri or northwest Arkansas and carried to Big Eddy on a seasonal round. This leaves two possibilities for its arrival (as a preform) at the Big Eddy site. It may represent Middle Paleoindian trade (Anderson 1995a; Hayden 1982; Hester and Grady 1977; Tankersley 1991), having been traded to a Gainey group living at Big Eddy by a neighboring group to the south, or it may have been carried to the Big Eddy site as a preform after a trip through the upper White River basin. The latter explanation seems less likely if the Gainey knappers were familiar with the Big Eddy area. This is because the lower Sac River

valley contains a very high quality chert resource (Ellipsoidal Jefferson City) equal to Lower Reeds Spring; therefore, there would have been no need to curate preforms made from Lower Reeds Spring chert and transport them a minimum distance of 100 km when Ellipsoidal Jefferson City chert was locally available.

On the other hand, if Gainey knappers were unfamiliar with the Sac River valley, they may have carried some preforms of high-quality Reeds Spring chert with them into an area where the quality of the local resources was unknown. Such a strategy would have been wise, for example, during forays into the heart of the Salem Plateau (to the east) or the Osage Plains (to the west) where the overall quality of chipped-stone resources is relatively poor. As a footnote, at least one other Gainey point knapped from Lower Reeds Spring chert was collected from a Cedar County site. This finished point (broken during use) was found near the Bear Creek–Spring Creek confluence in eastern Cedar County (Terry Collins, personal communication 1997). This indicates a north-south connection between the Lower Sac River valley and the upper White River valley during Middle Paleoindian times.

Late Paleoindian

Local Cherts

With a few minor differences, Late Paleoindian exploitation of local chert resources was essentially a continuation of Early/Middle Paleoindian practices. Jefferson City chert continued to comprise the overwhelming majority (84%) of Late Paleoindian artifacts. Ellipsoidal also continued to be the preferred variety of Jefferson City chert; however, it declined in use by approximately 10% with a corresponding increase in the use of Banded Jefferson City chert (Table 9.5). Other varieties of Jefferson City chert were used minimally. The exploitation of Chouteau chert increased to the point of being twice that of Burlington chert. The greatest exploitation of Chouteau chert (10.5%) may have occurred during Late Paleoindian times. The Woodland and late Early Archaic periods have slightly higher percentages, but these percentages may be skewed due to small sample sizes. Selection of Chouteau chert from Sac River gravels would have been intensive since it comprises only about 1% of the river gravel. Larger quantities of Chouteau chert, however, could have been obtained from residual deposits and from small feeder streams in upland areas to the east of the Big Eddy site.

Because the bulk of the Late Paleoindian assemblage is nondiagnostic debitage, there is little hard data that can differentiate Dalton chert selection and use from San Patrice lithic exploitation. Based on shear quantity, both components appear to have focused on Jefferson City chert. However, the degree of utilization of Jefferson City chert vs. Burlington and Chouteau and selection among the Jefferson City chert varieties are less clear. A few knapping features and potentially diagnostic artifacts, however, provide clues to differential raw-material preferences, especially between the two dominant varieties of Jefferson City chert: Ellipsoidal and Banded. Tentative cultural affiliation has been assigned to five knapping features based on potentially diagnostic artifacts such as preforms and hafted scrapers (see Chapter 8). Both Dalton and San Patrice knappers appear to have contributed to the largest knapping pile (Feature 28), so no conclusions are made based on this extensive feature. The other four knapping features, however, are small, discrete knapping piles that appear to be associated with a single component.

Features 23 and 27 are considered to be San Patrice knapping piles based on the direct association (refit and/or single-cobble origin) of small, rounded preforms (see Figure 8.33b, e; Figure 8.43b). Feature 23 yielded 46 flakes from multiple cobbles of Ellipsoidal Jefferson City chert, and Feature 27 yielded only 21 flakes from two Ellipsoidal Jefferson City chert cobbles (see Tables 8.10 and 8.15).

Features 29 and 45, on the other hand, appear to be affiliated with the Dalton component based on the association of a spurred end scraper (see Figure 8.25h) and a large, square-based preform (see Figure 8.27d), respectively. Feature 29 yielded 110 flakes from multiple cobbles representing a variety of raw materials (see Table 8.15). The dominant chert type in Feature 29 was Banded Jefferson City followed closely by Ellipsoidal Jefferson City. Feature 45 (on the cutbank) yielded 15 flakes probably knapped from at least three cobbles (two Banded and one Ellipsoidal). It is interesting to note that Features 29 and 45 represent two of only three knapping features in which Banded Jefferson City chert artifacts outnumber those made from Ellipsoidal Jefferson City chert. The other is Feature 28, which has both Dalton and San Patrice material.

These feature data suggest that San Patrice knappers were particularly focused on working Ellipsoidal Jefferson City chert, or at least (compared to Dalton knappers) San Patrice knappers had a stronger preference for working Ellipsoidal Jefferson City chert over Banded Jefferson City chert. This preference, however, was not to the exclusion of other varieties of Jefferson City chert. For example, of nine diagnostic and potentially diagnostic San Patrice artifacts (five preforms, three dart points, and one drill) that have been identified in the Late Paleoindian assemblage, 44% were knapped from the Ellipsoidal variety of Jefferson City chert with the remainder divided between the Banded (33.3%), Mottled (11.1%), and Oolitic (11.1%) varieties. A recent examination of two San Patrice (St. Johns variety) points found at Rodgers Shelter indicated that both were knapped from Jefferson City chert (one Ellipsoidal and one Mottled).

Although the majority of Dalton artifacts were also probably knapped from Ellipsoidal Jefferson City chert, Dalton knappers appear to have experimented with a wider variety of local resources. Chert typing of 16 diagnostic and potentially diagnostic Dalton artifacts (two adzes, three dart points, seven preforms, and four end scrapers) yielded the following percentages: 37.5% Ellipsoidal Jefferson City, 18.7% Banded Jefferson City, 18.7% Oolitic Jefferson City, 12.5% Burlington, 6.3% Chouteau, and 6.3% Quartzitic Jefferson City.

In sum, it appears that any differences between Dalton and San Patrice raw-material selection is one of degree rather than kind. Knappers in both components overwhelmingly preferred Jefferson City chert, and they probably made the majority of their chipped-stone artifacts out of Ellipsoidal Jefferson City chert. Dalton knappers, however, appear to have worked a greater percentage of Banded Jefferson City chert and to have experimented more with other resources (i.e., Burlington and Chouteau cherts). It must be stressed, however, that these observations are tentative based on a small sample of knapping features and a small sample of potentially diagnostic artifacts.

Exotic Cherts

Perhaps the most obvious difference between the Early/Middle Paleoindian and Late Paleoindian assemblages is the presence of several types of exotic chert in the latter. Four exotic Mississippian-age cherts, whose source areas are located south of the Ozark Divide in the southwestern Ozarks, were recovered from the Late Paleoindian horizon. Pitkin was the most common exotic chert with 20 specimens (Table 9.7). The majority of these were thin flake fragments and biface flakes produced by resharpening a curated bifacial tool(s) or possibly by late-stage reduction of a curated preform(s). Three tertiary flakes of Pitkin chert were also found; these could have been made by rejuvenating the bit of (unifacial) hafted end scrapers. Indeed, one exhausted end scraper of Pitkin chert was recovered from the cutbank (Figure 9.3h). Although the majority (70%) of Pitkin chert artifacts were concentrated in TU 11 and TU 14 (8 m^2), others were scattered about Blocks B and C, one was found in Block D approximately 20 m to the north, and one was found on the cutbank over 8 m south of Blocks B-C. This rather wide distribution of Pitkin chert artifacts suggests multiple episodes of Pitkin chert knapping of more than one artifact. At least one Pitkin chert artifact, a San Patrice (Hope variety) dart point, was identified in the Late Paleoindian collection from the nearby Montgomery site (Collins et al. 1983:35). An independent examination of this San Patrice point by the author confirmed the Pitkin chert identification.

Smaller quantities of Red Pierson, Lower Reeds Spring, and Middle Reeds Spring cherts were recovered from the Late Paleoindian component at the Big Eddy site (Table 9.7). Red Pierson chert artifacts consist of two informal tools (utilized flakes) and one flake fragment. All three were found in Block B. The two utilized flakes knapped from Red Pierson chert (Figure 9.3f-g) appear to represent backed knives. One exhibits cortex along a lateral edge, and the other has a smooth flake facet opposite the cutting edge. Lower Reeds Spring artifacts consist of two biface flakes from Block D and one hafted end scraper from the cutbank (Figure 9.3a). In addition, a Dalton point made from Lower Reeds Spring chert was found on the cutbank by Dan Long (see Figure 8.34b). Middle Reeds Spring artifacts consist of three hafted end scrapers and one side scraper (Figure 9.3b-e). Two of these scrapers were found on opposite sides of Blocks B and C and two were recovered from the cutbank. The physical attributes of most of the Red Pierson and Lower Reeds Spring chert artifacts indicate they could have derived from the Table Rock Lake area in southern Missouri or areas further south in northwest Arkansas. One Lower Reeds Spring end scraper and the four Middle Reeds Spring scrapers,

Table 9.7. Late Paleoindian Exotic Chert by Provenience.

Chert/Unit-Level	N	Chert/Unit-Level	N
Pitkin chert		Lower Reeds Spring chert	
Cutbank	1	Cutbank (ER-S/14, PCL/18)	2
TU-11-30	2	TU-10-30	1
TU-11-31	6	TU-10-32	1
TU-11-32	1		
TU-14-31	5	Red Pierson chert	
TU-16-31	1	TU-13-31	1
TU-19-30	1	TU-16-31	1
TU-25-31	1	TU-17-31	1
TU-26-30	1		
TU-30-31B	1	Winterset chert	
		TU-35-32	1
Middle Reeds Spring chert			
TU-15-31	1	Unidentified exotic chert	
TU-24-36B	1	Cutbank (G-S/5)	1
Cutbank (ER-S/1, ER-S/18)	2	TU-12-31	1
		TU-18-30	1
		TU-23-33A	1
		TU-8-31	1

Note: Includes material from cutbank not formally assigned to the Late Paleoindian component that probably belongs to it.

however, exhibit unique physical attributes (e.g., internal structure and coloration) not typically found in the Table Rock Lake area of Barry, Stone, and Taney counties. The closest sources of these particular raw materials are in southern McDonald County in extreme southwest Missouri and parts of northeast Oklahoma and northwest Arkansas.

Most of the above exotic Mississippian chert artifacts recovered from the Late Paleoindian levels suggest curation behavior. Practically all of these exotic chert artifacts are finished formal or informal tools (scrapers and flake knives) or late-stage waste flakes indicative of tool recycling/rejuvenation. This suggests that the small unifacial scraping tools, at least, were probably manufactured in the southern Ozarks and subsequently transported to the Big Eddy site on a seasonal round (i.e., embedded procurement). Although deemed less likely, these exotic chert scrapers could have arrived at the Big Eddy site via trade. Given the bountiful supply of chipped-stone raw materials in the Sac River valley, it is considered highly unlikely and entirely unnecessary that small flake blanks would have been traded to the site and subsequently made into scraping tools. It is plausible, however, that finished scrapers may have been exchanged to establish, maintain, or strengthen social and political ties between neighboring groups. The Pitkin chert artifacts and inferred multiple unifacial and bifacial tools may represent stronger possibilities of Late Paleoindian trade. Nevertheless, it is possible that they also simply represent the resharpening of curated tools.

Perhaps the best case for Late Paleoindian trade comes from a secondary biface knapped from an exotic Pennsylvanian chert. It was recovered from the lower portion of the 3Ab (310–315 cm bs) in Block D. This biface (Figure 9.3i) is a production failure knapped from a Reeds variety of Winterset chert. Reeds Winterset chert occurs only north of the Miami-Linn County line in eastern Kansas (Bert Wetherill, personal communication 1998) at a minimum distance of approximately 130 km northwest of the Big Eddy site. Based on its rectangular, lanceolate form, it is probably a Dalton preform; eastern Kansas is well within the range of the Dalton manifestation (Justice 1987:41). This artifact was transported to the Big Eddy site as a preform and

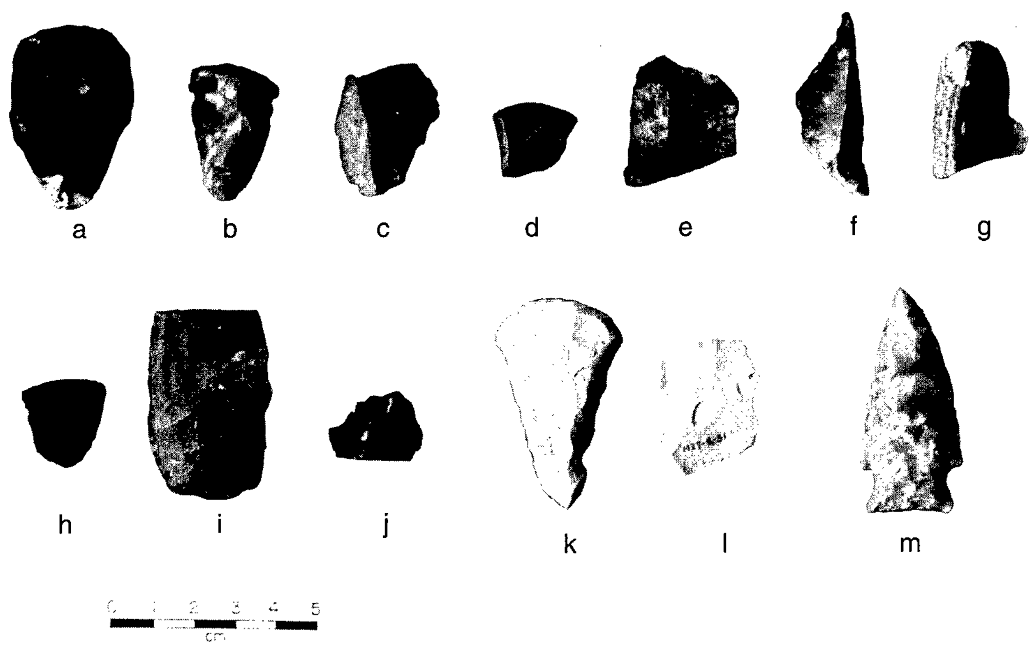


Figure 9.3. Selected exotic chert artifacts from the Late Paleoindian component. (a) end scraper made from Lower Reeds Spring chert; (b-e) scrapers made from Middle Reeds Spring chert; (f-g) backed knives made from Red Pierson chert; (h) end scraper made from Pitkin chert; (i-j) secondary biface and flake fragment made from Winterset chert; (k-l) end scraper and flake fragment made from unidentified Pennsylvanian cherts; (m) Wilson point made from an unidentified chert.

subsequently broken during lateral thinning by a side overshot fracture. This raises the question of why a preform of exotic chert would have been finished at the Big Eddy site. It would have been impractical to carry preforms of exotic chert a minimum distance of 130 km and then risk failure during late-stage thinning. Instead, it would seem more practical to manufacture artifacts at a distant source and transport only finished artifacts as functioning tools to other seasonal-round sites, particularly those located in the vicinity of multiple high-quality lithic resources. As such, it appears more likely that this exotic Dalton preform was transported to the Sac River valley as a trade item by a neighboring group and a subsequent (aborted) attempt was made to transform the traded preform into a Dalton projectile point/knife.

Five artifacts made from unidentified chert were also recovered from Late Paleoindian levels at the Big Eddy site, most of which appear to be exotic to the Ozarks region. The artifacts are two flake fragments, one biface flake, one end scraper, and one Wilson projectile point/knife. The Wilson projectile point/knife (Figure 9.3m) was manufactured from a nonfossiliferous, fine-grained, mottled gray chert (N 7/0, 6/0, 5/0). In some respects, this raw material resembles Edwards chert from central Texas (Banks 1990:60–61); however, it does not exhibit an orange coloration under ultraviolet light, which is characteristic of the vast majority of Edwards chert (Michael Collins, personal communication 1998). Based on a relatively fine, subangular, brecciated-like internal structure, it bears a stronger resemblance to a mottled variety of chert found in the Johns Valley Formation in the western Ouachita Mountains in southeast Oklahoma (Banks 1990:45-46).

One large flake fragment recovered from the middle portion of the Late Paleoindian horizon (Level 31) in TU 8 (Block B) was knapped from a

distinctive mottled brown chert (Figure 9.3l). Based on fossil content and other circumstantial evidence, it appears to be another exotic Pennsylvanian chert from the eastern Plains area. The same raw material was identified in a Graham Cave projectile point/knife (early Early Archaic) found just above the Late Paleoindian 3Ab horizon in Trench 2 approximately 30 m to the north. A detailed description and possible origins of this exotic chert are presented below. At a minimum, it appears to be another example of an exotic Plains chert arriving at the Big Eddy site via curation or trade.

Two other exotic chert artifacts are a flake fragment and a biface flake. The former specimen (Figure 9.3j) is dark gray to very dark gray (N 4/0, 3/0) and has been in direct contact with fire (potlidded). Although identification is not certain due to thermal alteration, it appears to be a variety of Winterset chert based on fossil content and other characteristics. The biface flake is very pale brown (10YR 8/3) and exhibits small mottles. Although classified as an unidentified exotic, it is possible that this specimen is an unusually high-grade piece of Burlington chert in which fossils were obscured to mottle-like structures during silica replacement.

In addition to the above exotic specimens recovered from excavated contexts, one Dalton hafted end scraper (Figure 9.3k) made from an exotic chert was found on the cutbank. This specimen is predominantly light gray (10YR 7/2) to very pale brown (10YR 7/3) in color and medium to fine grained in texture with many unidentified, microscopic white fossil fragments. Although unidentified as to specific formation or member, this chert is very likely a Pennsylvanian chert from the eastern Plains. It some respects it resembles three different (but similar) Pennsylvanian cherts: Laberdie chert, Argentine chert, and a light-colored variety of Winterset chert. These exotic cherts are located at minimum distances of 80–130 km northwest of the Big Eddy site.

Intersite Comparisons

Two nearby sites, Montgomery and Rodgers Shelter, contain sizeable collections of Late Paleoindian chert artifacts that can be compared to the Big Eddy assemblage for evaluating patterns of raw-material exploitation. The best comparison is the Montgomery site (located only 3.5 km to the southeast) since the availability of residual and alluvial deposits of Jefferson City, Chouteau, and Burlington cherts was nearly identical to that at the Big Eddy site. A comparison of materials from Rodgers Shelter is also appropriate since the same chert types are locally available there; however, specific availability (especially relative quantities) of each resource is slightly different in the lower Pomme de Terre River valley (Ray 1993:220–223).

Collins et al. (1983:31) reported a strong preference for Burlington chert (72%) in 39 Dalton specimens from the Montgomery site (74% of 38 Daltons, omitting one San Patrice specimen). This Dalton collection, as well as several other Early Archaic point types, was independently chert typed by the author three years ago (Table 9.8). Although this analysis resulted in a slightly different percentage for Burlington chert, it still revealed that two-thirds of the Montgomery Dalton points had been manufactured from Burlington chert, while less than one-third had been made from Jefferson City chert. These chert-utilization figures are radically different from those documented at Big Eddy. If the Dalton material from the Montgomery site is contemporaneous with the Big Eddy assemblage, it is difficult to explain this obvious discrepancy since the same or roughly contemporaneous knappers would likely practice similar exploitation patterns in virtually the same area.

It is probable, however, that this discrepancy is related to the inadequacies of comparing finished, diagnostic tools (Montgomery sample) with workshop debitage (Big Eddy sample). Diagnostic tools such as projectile points/knives are highly mobile (curated) artifacts and may have been manufactured at distant locations with radically different chert-resource availability (e.g., the region to the south [Dade, Lawrence, and Greene counties] dominated by Burlington chert). Even the six Dalton points known to have been collected from the Big Eddy site do not reflect the chert-use percentages in the workshop debitage. For example, two of the Big Eddy Dalton points were knapped from Burlington chert, two were knapped from Jefferson City chert, and one was knapped from exotic Lower Reeds Spring chert. It would be more appropriate, therefore, to examine the debitage collected during the Montgomery site testing and compare that with the Big Eddy workshop data. This collection was not examined for this report; however, a trip to study this collection at the curation facilities of the University of Missouri is planned for the near future.

Unfortunately, the only tabulated chert data of Dalton material from Rodgers Shelter is from 18

Table 9.8. Chert Utilization at Nearby Sites.

Site/Point Type	All Jefferson City Chert		Jefferson City Chert Ellipsoidal Variety		Jefferson City Chert Banded Variety		Jefferson City Chert Mottled Variety		Jefferson City Chert Oolitic Variety		Jefferson City Chert Quartzitic Variety		Chouteau Chert		Burlington Chert		Unidentified Exotic Chert		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Montgomery[a]																				
Dalton	12	31.6	6	15.8	1	2.6	2	5.3	2	5.3	1	2.6	1	2.6	25	65.8			38	100.0
Graham Cave	5	45.5	1	9.1			4	36.4					1	9.0	5	45.5			11	100.0
Rodgers Shelter[a]																				
Dalton	10	52.6	3	15.8	3	15.8	2	10.5	2	10.5			1	5.3	6	31.6	2	10.5	19	100.0
Searcy	34	82.9	10	24.4	7	17.1	9	22.0	8	19.5			1	2.4	6	14.6			41	100.0
Hidden Valley	36	90.0	10	25.0	4	10.0	15	37.5	6	15.0	1	2.5	1	2.5	3	7.5			40	100.0
Smith	29	80.6	7	19.4	9	25.0	9	25.0	4	11.1			2	5.6	5	13.9			36	100.0
Kings	22	81.5	18	66.7			2	7.4	2	7.4			2	7.4	3	11.1			27	100.0
Phillips Spring[b]																				
Upper Sedalia	74	93.7			51	64.6			23	29.1			2	2.5	3	3.8			79	100.0

[a]Chert identifications made by author.

[b]Chert identifications adapted from Robinson and Kay (1982:658–662).

Dalton projectile points/knives (Categories 10, 21–23). Of these, Kay (1982e:400–401) identified 61.1% as Jefferson City chert, 27.8% as Burlington chert, and 11.1% as Chouteau chert. A recent re-examination of 19 Dalton points from Rodgers Shelter curated at the Illinois State Museum revealed the following percentages: 52.6% Jefferson City, 31.6% Burlington, 5.3% Chouteau, and 10.5% unidentified exotic. The Dalton points made from Jefferson City chert were nearly evenly divided among the Ellipsoidal, Banded, Oolitic, and Mottled varieties (Table 9.8). Although more similar to the exploitation pattern at Big Eddy than Montgomery, the Rodgers Shelter Dalton points still do not reflect the overwhelming dominance of Jefferson City chert with a strong selection for the Ellipsoidal variety. As indicated above, the best comparison of on-site chert reduction would be to examine debitage recovered from Dalton living floors at Rodgers Shelter. Although no debitage was examined, a sample of 20 Dalton tools (13 preform production failures, five end scrapers, one drill, and one adze) recovered from Stratum I was identified as to chert type. Of this small sample, all but one (95%) were manufactured from Jefferson City chert, and most (47%) of these were made from the Mottled variety of Jefferson City chert. These tools, the majority of which represent workshop rejects, are considered better indicators of local raw-material selection and use by Dalton knappers at Rodgers Shelter. They indicate an obvious Late Paleoindian preference for working Jefferson City chert very similar to that found at the Big Eddy site. The apparent selection for Mottled Jefferson City chert over the Ellipsoidal and Banded varieties may reflect variations in quantity and quality among the Jefferson City chert varieties in the Rodgers Shelter locale relative to the Big Eddy site area.

Early Early Archaic

Local Cherts

The chert-exploitation patterns established in the Paleoindian period continued with only minor changes during the early part of the Early Archaic period (Table 9.5). The use of Jefferson City chert declined only slightly with a corresponding increase in the use of Burlington chert to the same degree of exploitation as Chouteau chert (approximately 10%). Within the Jefferson City type, the Mottled, Oolitic, and Quartzitic varieties increased slightly at the expense of the Ellipsoidal and Banded varieties.

Exotic Cherts

Two exotic chert types were identified in the early Early Archaic assemblage: two flake fragments of Pitkin chert and one projectile point/knife made from an unidentified chert. One Pitkin flake was found in Level 26 (250–260 cm bs) of TU 8 and the other was recovered from Level 28 (270–280 cm bs) in TU 11. At least the former Pitkin flake, found approximately 30–40 cm above the Dalton horizon, is unlikely to represent a Dalton Pitkin flake bioturbated into early Early Archaic deposits.

Although unidentified as to parent rock formation, the other exotic chert (identified in a Graham Cave point from Trench 2) is almost certainly a Pennsylvanian chert from the eastern Plains area. It consists of a distinctive fine-grained, very pale brown (10YR 7/4) and light yellowish brown (10YR 6/4) chert with small, very pale brown (10YR 8/3) mottles. The mottles, which are elongated in oblique cross-section, appear to be replaced worm burrows (1.5–2.5 mm in diameter) with inclusive microscopic fossil detritus. Unfragmented, unidentified microfossils (0.2–0.7 mm in diameter) located outside burrows are round to oval in shape with an external botryoidal appearance. The same raw material was identified in the Late Paleoindian 3Ab horizon in Level 31 (300–310 cm bs). The Late Paleoindian flake and early Early Archaic knife are separated laterally by approximately 30 m and vertically by 35–45 cm. Thus, there is little chance these two items are related spatially or temporally.

This exotic chert is somewhat similar in color and texture to Plattsmouth chert found in eastern Kansas (Chautauqua County northeast to Doniphan County), approximately 180–300 km west and northwest of the Big Eddy site. Outcrops of chert-bearing Plattsmouth limestone are most common in northeastern Kansas (Hill 1955:7–9). In some respects the exotic chert also resembles chert in the Laberdie (or Coal City) member of the Pawnee Formation located in Bates and northwestern Vernon counties, Missouri, and in parts of eastern Kansas at least 80+ km northwest of the site (Gentile 1976:21–22; Jewett et al. 1968:25). Comparative field samples of these two Pennsylvanian cherts, however, tend to be more fossiliferous and do not exhibit the characteristic worm burrows evident in the archaeological specimens. If it is Plattsmouth or Laberdie

chert, it must be an unusual localized variety. Additional evidence that it is probably an eastern Plains chert is the presence of a flake scraper made from the same raw material at a Neosho phase site (23LA259) in southwest Missouri. All of the identified exotic cherts from this Neosho site derived from the eastern Plains (Ray 1996:94–98). The Neosho phase is centered in northeast Oklahoma and is probably related to other similar, contemporaneous late-prehistoric phases (e.g., Pomona and Great Bend) centered in east-central and southeastern Kansas (J. Brown 1984; Conner 1996; Vehik 1994; Witty 1981).

Late Early Archaic

All of the late Early Archaic artifacts found at the Big Eddy site were knapped from the three dominant local raw materials. Although the sample is relatively small (n=31), it is probably indicative of general late Early Archaic chert use. This component reflects the first radical shift in chert exploitation at the Big Eddy site. Comprising approximately 55% of the total assemblage, Burlington chert replaced Jefferson City chert as the primary chert resource (Table 9.5). Jefferson City chert became a secondary or supplemental resource comprising only about one-quarter of the artifacts. For the first time, there also appears to have been little selection among the different varieties of Jefferson City chert. Chouteau chert also appears to have been a secondary resource during late Early Archaic times.

The above utilization percentages are considered tentative because of the relatively small sample size and because some of the late Early Archaic sample is composed of diagnostic artifacts. On the other hand, the exclusion of diagnostic artifacts and consideration of only core and flake debitage (n=24) also reveals a dominance of Burlington chert (58%). Thus, a shift away from Jefferson City chert to Burlington chert is evident, although more precise utilization percentages must await the excavation and analysis of a much larger sample of late Early Archaic debitage.

Early Late Archaic

Selection for Burlington chert appears to have increased significantly by the early part of the Late Archaic period as represented by the Smith-Etley component (Table 9.5). Fully three-quarters of the early Late Archaic assemblage is composed of Burlington chert. Jefferson City chert continued to be exploited as a secondary resource and there apparently was little preference for working one variety of Jefferson City chert over another. In addition to Burlington chert and Jefferson City chert, one piece of Warner (redeposited Burlington) chert was also identified in the artifact sample.

The Late Archaic Sedalia component at Phillips Spring in the Pomme de Terre River valley reveals a different pattern of chert use (Robinson and Kay 1982:658–662). This "Upper Sedalia" component sample, comprised of 10 points (Smith/Stone, Sedalia, and Etley), 39 bifaces, and 29 cores, revealed a strong preference for Jefferson City chert (93.7%) with the remainder divided between Burlington (3.8%) and Chouteau (2.5%) cherts (Table 9.8). The reversal of primary resources at Phillips Spring is probably related to a reversal in availability of local resources. For example, higher-quality Jefferson City chert dominates ridge slopes in the general vicinity of Rodgers Shelter (Ray 1993:220–223), and it is much more abundant in the gravels of the Pomme de Terre River than in the Sac River at Big Eddy. What is interesting is that in contrast to the Big Eddy site, the Dalton and Late Archaic lithic assemblages in the Pomme de Terre River valley show no diachronic shift in chert use (both >90% Jefferson City). This appears to reflect adaptive Late Archaic use of the dominant local resource regardless of quality, whereas Dalton knappers concentrated on the highest-quality resources.

A fairly large sample of early Late Archaic projectile points/knives was recovered from the Big Eddy site (Table 9.6). The majority of these points are Smith Basal Notched (n=16). Seven of the Smith points were manufactured from Burlington chert, but a relatively wide range of other raw materials is also represented. Several varieties of Jefferson City chert are evident with a combined percentage of 43.8%. The much higher percentage of Jefferson City chert in projectile points/knives vs. debitage may indicate curation from neighboring areas such as the Pomme de Terre River valley. Other raw materials identified in the Smith Basal Notched collection include the only artifact from the Big Eddy site made from Jefferson City quartzite and one hafted biface knapped from exotic Lower Reeds Spring chert. Both of these projectile points/knives could represent curated artifacts from areas to the east and south. A total of 51 Smith Basal Notched and Stone Square Stemmed points were recovered from

the Stockton Lake area; 78.4% were made from Burlington chert, 19.6% were knapped from Jefferson City chert, and 2.0% were manufactured from exotic (Lower) Reeds Spring chert (Klinger et al. 1993:Table 96).

Middle Late Archaic

The most selective chert procurement at the Big Eddy site was practiced during middle Late Archaic times by Williams component knappers (Table 9.5; Figure 9.2). Fully 95% of this assemblage was manufactured from Burlington chert. Jefferson City chert was relegated to a tertiary resource with Chouteau chert exploitation purely incidental. The preference for Burlington chert in the Williams component even eclipsed the intensive selection for high-quality, low-quantity Jefferson City chert by Paleoindian knappers. The extremely focused exploitation of poorer-quality Burlington chert by Williams component knappers to the near exclusion of other local resources is apparently related to at least two factors. One is a continued reliance of Late Archaic knappers on working the most abundant and easily accessible resource, and the other appears to be a universal application of thermal alteration to bifaces (see Heat Treatment below). A highly skilled application of heat treatment to most cobbles of Burlington chert improves its knappability immeasurably. As expected from such a selective technology, all six Williams points were knapped from Burlington chert (Table 9.6). No exotic chert artifacts occur in the Williams component assemblage.

Woodland/Late Archaic

The sample of debitage collected from mixed Woodland and Late Archaic deposits (TU 6 and stripped surface) is similar to early Late Archaic chert usage (Table 9.5). It reflects a return to the exploitation of Jefferson City chert as a secondary resource and other local cherts as tertiary resources, in contrast to the nearly exclusive procurement and use of Burlington chert by the Williams component knappers (middle Late Archaic period).

Woodland

The Woodland chert sample is relatively small and highly biased toward curated tools such as projectile points/knives. Indeed, all but eight of the sample of 33 artifacts in Table 9.5 represent Woodland projectile points. As a result, the percentages probably are not accurate reflections of Woodland chert selection and reduction at the Big Eddy site. It is perhaps a better reflection of general chert exploitation within a much larger area such as the Sac River valley and possibly adjacent valleys.

Kings Corner Notched (n=18) is the most dominant Woodland point type. Although a relatively small sample, it suggests that the makers of Kings Corner Notched points in the general project area focused their attention on Mississippian chert resources, especially Burlington chert (67%, Table 9.6). This is supported by 56 Kings Corner Notched points collected from Stockton Lake, of which 75% were manufactured from Burlington chert (Klinger et al. 1993:Table 96).

Other Woodland points from the Big Eddy site are too few in number to extrapolate chert preferences. It is interesting to note that the one exotic Woodland specimen, a Waubesa Contracting Stemmed point, was manufactured from Florence B chert, probably derived from east-central Kansas or north-central Oklahoma.

Woodland/Mississippian

The sample of mixed Woodland and Mississippian artifacts reflects a continuation of the generalized Woodland/Late Archaic and early Late Archaic patterns (Table 9.5). One difference, however, appears to be a selection among the available varieties of Jefferson City chert, i.e., Ellipsoidal over the other five varieties.

A small sample (n=12) of Scallorn Corner Notched arrowpoints (Table 9.6) gives a preliminary indication of resource selection by a select group of Late Woodland/Mississippian knappers in the lower Sac River valley. Two-thirds of these corner-notched arrowpoints were manufactured from Burlington chert, one-quarter was made from Jefferson City chert, and the remainder were knapped from Chouteau chert. A larger sample of 62 Scallorn points from the Stockton Lake area supports the Big Eddy data with similar chert-use percentages of 77.4% Burlington chert and 22.6% Jefferson City chert (Klinger et al. 1993:Table 96).

CHERT PROCUREMENT

Before discussing raw-material procurement patterns, brief definitions and descriptions of

modes of procurement and lithic sources are presented.

Modes of Procurement

There were three basic ways that prehistoric knappers planned or organized the procurement or acquisition of raw materials: direct, embedded, and indirect. *Direct procurement* refers to the predetermined or planned removal of raw material from specific well-known sources. Raw material obtained by direct means may be local or nonlocal to a specific site or study area. Special trips to nonlocal sources may be made on an intermittent basis, or local task groups may be organized to exploit the resource on a semipermanent basis and distribute the raw material to outlying areas. A resource that is procured directly from a nonlocal source is generally of high quality due to the amount of energy expended and special effort made to obtain the material. Acquisition of raw material by the direct method can be in small or large quantities.

Embedded procurement is a form of direct procurement. It refers to the casual procurement of local resources while pursuing subsistence activities or during seasonal movements without procurement being a planned or predetermined special activity (Binford 1979:259–260). Embedded procurement was often expedient in that local lithic resources were exploited casually on an as needed basis. Embedded procurement also could be opportunistic where exceptionally high-quality raw material could not be passed-up while engaged in other activities. Because the procurement, whether expedient or opportunistic, is embedded in other activities, the procured material would tend to be in small quantities at any one time.

Indirect procurement refers to obtaining raw material through the mediation of an individual or social group and generally involves the exchange or trade of resources of equal value. Exchange could be between two dependent groups or several independent groups (down-the-line exchange). The exchanged lithic items are usually preforms or finished artifacts made of exotic raw materials and are therefore valued commodities. Items obtained via indirect procurement tend to be maximally utilized through recycling and maintenance due to the acquisition costs and exotic nature of the resource. The amount of raw material procured via the indirect method depends on demand, social and political ties, and distance to the raw material.

Lithic Sources

Lithic *sources* are specific locations on the landscape where chert *resources* can be found and from which prehistoric procurement of raw material took place. There were three distinct types of lithic sources potentially available to prehistoric knappers in the project area, each manifested in a different context: (1) bedrock sources, (2) residual sources, and (3) alluvial sources.

A *bedrock source* consists of deposits (nodules, lenses, or beds) of chert still embedded or consolidated in a bedrock matrix. Bedrock deposits can be found in natural stream cuts (cutbanks or bluffs), exposures resulting from severe regolith erosion, and open glade areas. Procurement of bedrock chert usually involves laborious mining or quarrying into the surrounding bedrock matrix to dislodge the raw material.

A *residual source* refers to deposits of chert removed from the original bedrock matrix via chemical and physical weathering. These free nodules occur on or in the ground and are often referred to as residual float. Residual raw material may be procured directly from the ground surface with the least amount of effort, or less weathered, better quality subsurface residuum may be quarried from the regolith below the frost line. Residual chert is identified by angular shape and sugary textured or grainy cortical surfaces.

An *alluvial source* refers to any stream-gravel deposit (e.g., gravel bars). Alluvial deposits consist of chert cobbles that have been eroded, transported, and secondarily redeposited into creeks and rivers by stream action. These alluvial gravels have been eroded from bedrock and residual sources upstream and aggregate in extensive gravel bars along stream courses (especially at confluence areas and on the inside of meanders). Stream-deposited chert is easily identified by its water-worn, smooth cortex and a reddish brown patina, a result of fluvial corrasion and corrosion and hydration. Stream-deposited raw material is procured directly from stream-bed gravel bars with a minimal expenditure of effort.

Procurement Practices

Patterns of raw-material procurement were investigated by examining the relict cortical surfaces on initial-reduction artifacts such as cores, decortication flakes, and primary bifaces, or any artifacts

that exhibited cortical surfaces. Identifications of cortex type were made according to the respective attributes outlined in the above discussion of lithic sources (i.e., angular or grainy nonabraded cortex=residual; smooth, water-worn cortex=alluvial). It must be noted that because the cortex of bedrock chert is indistinguishable from residual-chert cortex, any such material would be included in the residual category. However, since documented examples of actual bedrock quarries are very rare in the Ozarks, the vast majority, if not all, of the cortical surfaces identified as residual probably represent chert procured from residual deposits.

Table 9.9 and Figure 9.4 present the cortical data in tabular and graphic forms by component. With one exception, all excavated lithic artifacts from each component were examined for presence of cortex and differentiated as residual, alluvial, or indeterminate. Due to the extremely large collection from the 3Ab horizon (lithic workshop), only decortication flakes (i.e., primary and secondary flakes) were analyzed as to cortical type for the Late Paleoindian component. Four components are represented by relatively large sample sizes that are probably indicative of prehistoric procurement practices. Those components with 25–30 cortical specimens are discussed in tentative terms, and those with less than 20 cortical specimens are presented in Table 9.9, but they are omitted from Figure 9.4 and from the comparative discussion of procurement practices below.

Early/Middle Paleoindian

It appears that Early/Middle Paleoindian knappers procured the vast majority of their raw material from alluvial sources. This was clearly the case with the procurement of Jefferson City chert, and the same method was probably used for collecting small amounts of other cherts such as Chouteau and Burlington (Table 9.9). Indeed, it is possible that even the four cortical Jefferson City artifacts identified as residual cortex were also procured from alluvial sources. Jefferson City chert, especially the Ellipsoidal variety, has a thin, smooth cortex that is often difficult to differentiate, particularly on cobbles that had been exposed to limited stream corrasion prior to procurement (e.g., cobbles added to the river from colluvial deposits only shortly before procurement, and cobbles transported only short distances in small feeder streams). In fact, it is unlikely that some of the first transient inhabitants of the Sac River valley would have had time to locate the small, localized outcrops and residual deposits of Jefferson City chert located upstream and downstream of the Big Eddy site (see Figure 2.2) before moving on. For short-term Early/Middle Paleoindian occupations, it would appear to have been more practical to intensively search local gravel bars for the high-quality, and characteristic, ellipsoidal-shaped cobbles of Jefferson City chert than to search for isolated residual deposits. Although they comprise less than 2% of the river gravels in the Sac River, it rarely takes more than a few minutes to find several Ellipsoidal Jefferson City chert cobbles along the expansive gravel-bar deposits (personal observations).

Late Paleoindian

By far the best cortical data were derived from the workshop debitage in the Late Paleoindian 3Ab horizon in which over 1,300 cortical artifacts were recovered and analyzed (Tables 9.9 and 9.10). Most interpretations will be restricted to "undifferentiated Late Paleoindian" due to nondiagnostic attributes of most cortical artifacts; however, given the overwhelming dominance of alluvial cortex in the Late Paleoindian assemblage, it is probable that both Dalton and San Patrice knappers collected their raw materials primarily from stream deposits. All of the potentially diagnostic preforms with identifiable cortical surfaces exhibit alluvial cortex.

Like their Early/Middle Paleoindian predecessors, Late Paleoindian knappers procured most of their raw material from alluvial sources. Nevertheless, there appear to be some differences in source procurement according to chert type and variety. As a whole, approximately 80% of Jefferson City chert came from stream deposits. Both of the dominant varieties, Ellipsoidal and Banded, were procured primarily from alluvial sources; however, at least one-quarter of Banded Jefferson City chert appears to have been collected from residual sources (Table 9.10). This suggests that one or more local outcrops of Jefferson City strata, such as the small window upstream at 23CE500, was discovered and exploited by Late Paleoindian knappers. Assuming the Dalton component represents the resident or local population, it is probable that Dalton knappers found and made occasional use of these limited residual sources.

The procurement of Burlington chert was almost entirely from local stream deposits, whereas a

Table 9.9. Cortex Type by Component.

Period/Raw Material	Residual Cortex N	Residual Cortex %	Alluvial Cortex N	Alluvial Cortex %	Indeterminate Cortex N	Indeterminate Cortex %	Total N	Total %
Woodland/Mississippian								
Burlington chert	6	33.3	10	55.6	2	11.1	18	100.0
Chouteau chert	1	50.0	1	50.0			2	100.0
Jefferson City chert	2	22.2	7	77.8			9	100.0
Total	9	31.0	18	62.1	2	6.9	29	100.0
Woodland								
Burlington chert			3	100.0			3	100.0
Chouteau chert			1	100.0			1	100.0
Jefferson City chert			1	100.0			1	100.0
Total			5	100.0			5	100.0
Woodland/Late Archaic								
Burlington chert	8	44.4	7	38.9	3	16.7	18	100.0
Chouteau chert	1	50.0	1	50.0			2	100.0
Jefferson City chert	1	33.3	1	33.3	1	33.3	3	100.0
Other chert			2	100.0			2	100.0
Total	10	40.0	11	44.0	4	16.0	25	100.0
Middle Late Archaic								
Burlington chert	89	55.6	54	33.8	17	10.6	160	100.0
Jefferson City chert	3	30.0	4	40.0	3	30.0	10	100.0
Other chert			1	100.0			1	100.0
Total	92	53.8	59	34.5	20	11.7	171	100.0
Early Late Archaic								
Burlington chert	13	61.9	7	33.3	1	4.8	21	100.0
Jefferson City chert	1	33.3	1	33.3	1	33.3	3	100.0
Other chert			1	100.0			1	100.0
Total	14	56.0	9	36.0	2	8.0	25	100.0
Middle Archaic								
Burlington chert	2	100.0					2	100.0
Jefferson City chert	1	50.0	1	50.0			2	100.0
Total	3	75.0	1	25.0			4	100.0
Late Early Archaic								
Burlington chert	5	55.6	2	22.2	2	22.2	9	100.0
Chouteau chert	1	50.0	1	50.0			2	100.0
Jefferson City chert			1	50.0	1	50.0	2	100.0
Total	6	46.2	4	30.8	3	23.1	13	100.0
Early Early Archaic								
Burlington chert			7	100.0			7	100.0
Chouteau chert	1	20.0	3	60.0	1	20.0	5	100.0
Jefferson City chert	6	8.5	56	78.9	9	12.7	71	100.0
Total	7	8.4	66	79.5	10	12.0	83	100.0
Late Paleoindian								
Burlington chert	6	6.5	84	90.3	3	3.2	93	100.0
Chouteau chert	32	30.8	64	61.5	8	7.7	104	100.0
Jefferson City chert	139	12.4	900	80.5	79	7.1	1,118	100.0
Other chert	2	100.0					2	100.0
Total	179	13.6	1,048	79.6	90	6.8	1,317	100.0
Early/Middle Paleoindian								
Burlington chert			6	85.7	1	14.3	7	100.0
Chouteau chert			5	71.4	2	28.6	7	100.0
Jefferson City chert	4	5.4	63	85.1	7	9.5	74	100.0
Total	4	4.5	74	84.1	10	11.4	88	100.0
Total	324	18.4	1,295	73.6	141	8.0	1,760	100.0

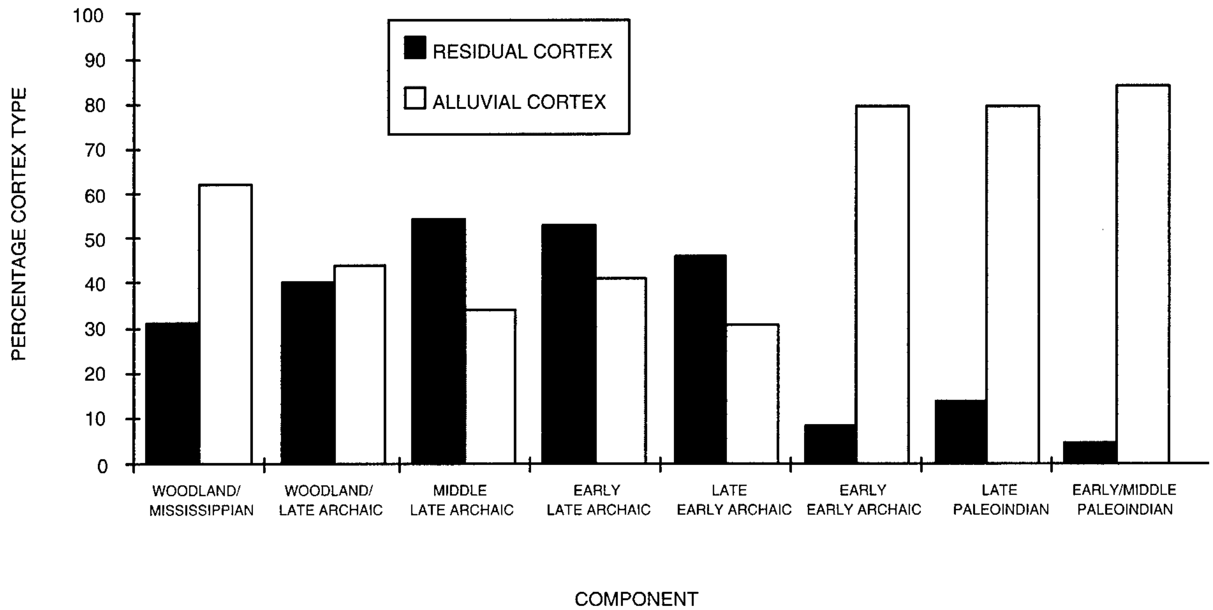


Figure 9.4. Cortex type by component.

Table 9.10. Late Paleoindian Source Procurement by Raw-Material Type.

	Residual Cortex		Alluvial Cortex		Intermediate Cortex		Total	
Raw Material	N	%	N	%	N	%	N	%
Burlington chert	6	6.5	84	90.3	3	3.2	93	100.0
Chouteau chert	32	30.8	64	61.5	8	7.7	104	100.0
Jefferson City chert	139	12.4	900	80.5	79	7.1	1,118	100.0
Banded variety	65	26.7	147	60.5	31	12.8	243	100.0
Conglomeritic variety			5	100.0			5	100.0
Ellipsoidal variety	63	7.9	693	87.3	38	4.8	794	100.0
Mottled variety	8	13.8	45	77.6	5	8.6	58	100.0
Oolitic variety	1	8.3	7	58.3	4	33.3	12	100.0
Quartzitic variety	2	33.3	3	50.0	1	16.7	6	100.0
Pitkin chert	1	100.0					1	100.0
Red Pierson chert	1	100.0					1	100.0
Total	179	13.6	1,048	79.6	90	6.8	1,317	100.0

significant portion (nearly one-third) of Chouteau chert appears to have been acquired from residual sources. The procurement of significant amounts of Chouteau chert from residual deposits is probably related to two physical factors: (1) Chouteau chert comprises less than 1% of the gravels in the Sac River (Table 9.2); and (2) relatively abundant residual deposits are located in the uplands a short distance east and northeast of the Big Eddy site. At least one site with evidence of raw-material testing and initial reduction (23CE501) was recorded in a ravine 2.2 km east of the Big Eddy site.

An examination of cortical artifacts from Late Paleoindian levels at the Montgomery site and Rodgers Shelter also revealed a preference for working stream-deposited chert cobbles (Collins et al. 1983:67; Kay 1982c:732).

Early Early Archaic

The same Paleoindian source-procurement practices appear to have continued into the early part of the Early Archaic period. For example, virtually the same percentage of Jefferson City chert (79%) was procured from alluvial sources by early Early Archaic knappers (Table 9.9) as their Late Paleoindian predecessors. Although sample sizes of Burlington and Chouteau cortical artifacts are small, the procurement patterns associated with these supplemental resources were also probably similar to those practiced during Late Paleoindian times.

Early Late Archaic

Early Late Archaic cortical percentages are tentative due to small sample size; however, it is apparent that by the early part of the Late Archaic period a shift had been made to procuring the majority of chert from residual sources. This particular pattern is at least true of the primary resource, Burlington chert (Table 9.9). The main reason for a predominant reliance on residual deposits during this time is probably related to the shift in chert utilization to Burlington chert. Late Archaic knappers tended to focus on the more readily accessible and abundant Burlington chert. To enhance the knappability of this relatively inferior chert, they often employed thermal alteration, which had been perfected during the Middle Archaic period. The use of thermal alteration greatly increased the knapping quality of raw Burlington chert and allowed Archaic knappers to exploit the large quantities of locally available Burlington chert. The specific early Late Archaic procurement patterns associated with Jefferson City and Chouteau cherts must await future excavations at the Big Eddy site and the collection of much larger samples of cortical artifacts. A preference for collecting chert from residual sources during Late Archaic times was also noted for an Upper Sedalia assemblage from Phillips Spring (Robinson and Kay 1982:666).

Middle Late Archaic

Excavations in the Williams component midden produced the second-largest sample of cortical artifacts from the Big Eddy site. It is clear from this sample that Williams component knappers preferred to procure the majority of their Burlington chert from residual sources (Table 9.9). The closest residual source is the talus deposit along the base of the steep bluff slope bordering the west side of the river across from the Big Eddy site (see Figure 2.2). Nodular and discontinuous bedded deposits of Burlington chert up to 10–12 cm thick also can be found in the middle and upper portions of the bluff, but access to and procurement of these in situ bedrock deposits would have proved more difficult than exploiting the loose residual deposits at the base of the ridge. Although appreciable quantities of residual Burlington chert occur along the base of the adjacent bluff line, more extensive residual deposits are located in the uplands just west of the bluff line. In addition to residual deposits, Williams component knappers procured at least one-third of their Burlington chert from alluvial sources, probably from nearby gravel bars in the Sac River. Due to a strong preference for Burlington chert, cortical data for other local cherts are tentative at best. Nevertheless, most of the small amount of Jefferson City chert that was procured probably came from river gravels, incidental to the procurement of stream-deposited Burlington chert.

Woodland/Late Archaic

Little can be interpreted from the small sample of mixed Woodland and Late Archaic cortical artifacts. With respect to the two previous Late Archaic components and Burlington chert procurement, the percentage of residual cortical artifacts is less, with a concomitant increase in alluvial cortical artifacts. This appears to be due to a mixed Archaic/Wood-

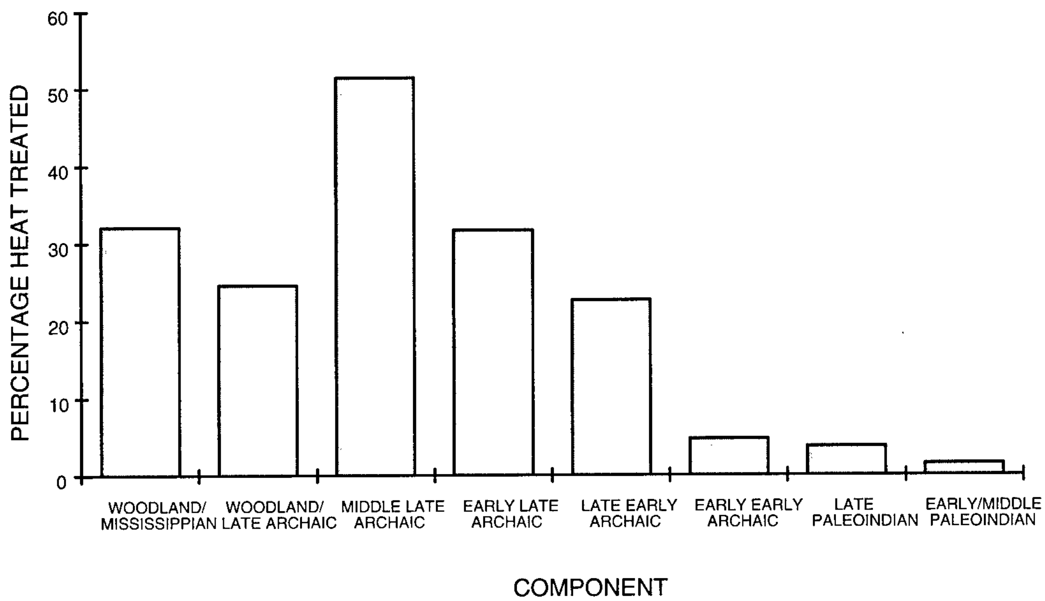


Figure 9.5. Heat treatment by component.

land assemblage and a reflection of shifting procurement strategies during the succeeding Woodland and Mississippian periods.

Woodland/Mississippian

Although cortical artifacts from the Woodland/Mississippian component are relatively few, it is apparent that in post-Archaic times, a second shift in source procurement occurred, i.e., back to a primary reliance on stream-deposited chert (Table 9.9; Figure 9.4). Indeed, with respect to Burlington chert procurement, the percentages of residual and alluvial cortical artifacts in the undifferentiated Woodland/Mississippian component are the exact opposite of the middle Late Archaic percentages. The reason for favoring alluvial-source procurement during late-prehistoric times is unclear.

HEAT TREATMENT

The identification of heat-treated artifacts was based primarily on the presence of highly lustrous flake scars, contrasting dull and lustrous flake scars, and a knowledge of the range of natural luster of the local raw materials. Unnatural color alteration and closely spaced ripple marks were also considered but were secondary criteria to luster. Artifacts exhibiting heat spalls (potlids), crazing, and/or a smoked (fire-blackened) appearance were not identified as having been heat treated (i.e., intentionally thermally altered) since these attributes can occur on discarded artifacts that were tossed into hearths or otherwise unintentionally heated after manufacture and use. In this chapter, no distinction is made between the terms "heat treated" and "thermally altered" in regard to intentional modification vs. unintentional or natural modification.

The presence of heat-treatment attributes was noted on all excavated artifacts for most components; however, only biface flakes were examined for thermal alteration in the large Late Paleoindian assemblage. Heat-treatment data are presented by component in Figure 9.5 and by component and raw-material type in Table 9.11. Table 9.12 breaks the lithic assemblages into bifacial tools and flake debitage by component. Table 9.11 includes artifacts from excavated or stratigraphic contexts only, whereas Table 9.12 includes diagnostic artifacts from all contexts (e.g., cutbank, private collections, etc.). Only those components represented by 30 or more artifacts are discussed below.

Table 9.11. Heat Treatment by Component and Raw-Material Type.

	Heat Treated		Not Heat Treated		Total	
Component/Raw Material	N	%	N	%	N	%
Woodland/Mississippian						
Burlington chert	28	34.6	53	65.4	81	100.0
Chouteau chert	3	60.0	2	40.0	5	100.0
Jefferson City chert	4	17.4	19	82.6	23	100.0
Total	35	32.1	74	67.9	109	100.0
Woodland						
Burlington chert	18	100.0			18	100.0
Chouteau chert	3	75.0	1	25.0	4	100.0
Jefferson City chert	3	30.0	7	70.0	10	100.0
Other chert			1	100.0	1	100.0
Total	24	72.7	9	27.3	33	100.0
Woodland/Late Archaic						
Burlington chert	27	28.1	69	71.9	96	100.0
Chouteau chert			5	100.0	5	100.0
Jefferson City chert	5	18.5	22	81.5	27	100.0
Other chert			2	100.0	2	100.0
Total	32	24.6	98	75.4	130	100.0
Late Late Archaic						
Burlington chert	6	100.0			6	100.0
Middle Late Archaic						
Burlington chert	314	53.1	277	46.9	591	100.0
Chouteau chert	2	100.0			2	100.0
Jefferson City chert	4	14.3	24	85.7	28	100.0
Other chert			1	100.0	1	100.0
Total	320	51.4	302	48.6	622	100.0
Early Late Archaic						
Burlington chert	25	40.3	37	59.7	62	100.0
Jefferson City chert			15	100.0	15	100.0
Other chert			2	100.0	2	100.0
Total	25	31.6	54	68.4	79	100.0
Middle Archaic						
Burlington chert			10	100.0	10	100.0
Jefferson City chert			3	100.0	3	100.0
Total			13	100.0	13	100.0
Late Early Archaic						
Burlington chert	2	11.8	15	88.2	17	100.0
Chouteau chert	3	50.0	3	50.0	6	100.0
Jefferson City chert	2	25.0	6	75.0	8	100.0
Total	7	22.6	24	77.4	31	100.0
Early Early Archaic						
Burlington chert	3	8.6	32	91.4	35	100.0
Chouteau chert	2	5.6	34	94.4	36	100.0
Jefferson City chert	12	4.2	277	95.8	289	100.0
Other chert			3	100.0	3	100.0
Total	17	4.7	346	95.3	363	100.0

Table 9.11. Heat Treatment by Component and Raw-Material Type. (Continued).

	Heat Treated		Not Heat Treated		Total	
Component/Raw Material	N	%	N	%	N	%
Late Paleoindian[a]						
Burlington chert	29	17.0	142	83.0	171	100.0
Chouteau chert	12	3.3	357	96.7	369	100.0
Jefferson City chert	76	2.9	2,544	97.1	2,620	100.0
Other chert			7	100.0	7	100.0
Total	117	3.7	3,050	96.3	3,167	100.0
Early/Middle Paleoindian						
Burlington chert			30	100.0	30	100.0
Chouteau chert	2	4.9	39	95.1	41	100.0
Jefferson City chert	6	1.3	452	98.7	458	100.0
Other chert			1	100.0	1	100.0
Total	8	1.5	522	98.5	530	100.0
Pre-Clovis						
Burlington chert			2	100.0	2	100.0
Jefferson City chert			3	100.0	3	100.0
Total			5	100.0	5	100.0

[a] Biface flakes only.

Early/Middle Paleoindian

Very little of the Early/Middle Paleoindian material was thermally altered. Indeed, only eight artifacts (1.5%) exhibit evidence of thermal alteration, all of which may have been heated unintentionally by accidental inclusion or incidental discard into hearths. Two fluted-point fragments briefly examined in private collections appeared to have been heat treated; however, these points were manufactured from exceptionally high-quality and lustrous raw material that mimics thermal alteration. The Gainey refit from TU 25 also exhibited thermal-alteration attributes; however, angular fractures on this specimen indicate direct contact with fire, and therefore, heat alteration was probably unintentional or the result of discard into a hearth.

Few Early/Middle Paleoindian studies discuss heat treatment, presumably due to the general absence of heat-treated specimens from early prehistoric sites. J. Morrow (1996:98), however, did note that none of the Early Paleoindian bifaces from the Ready/Lincoln Hills site had been intentionally heat treated. An extensive survey of several hundred Early/Middle Paleoindian points in the Midwest by Toby and Julie Morrow also revealed no intentionally heat-treated specimens (Julie Morrow, personal communication 1998).

Late Paleoindian

Only biface flakes, the most likely of all debitage types to exhibit thermal alteration, were examined for heat treatment. As a whole, less than 4% of Late Paleoindian biface flakes were heat altered. As for specific chert type, very little of the Jefferson City and Chouteau cherts were thermally altered, whereas 17% of Burlington chert artifacts were identified as heat treated (Table 9.11). The Burlington chert data, however, appear to be skewed by exceptionally fine-grained and highly lustrous (psuedo heat-treated) debitage, most of which can be traced to the reduction of two bifaces. The Burlington chert represented in these two bifaces and associated biface flakes was noted as unusual in appearance. This unusual Burlington chert probably represents non-heat-treated material curated or traded to the Big Eddy site from an exceptionally high-quality source(s) outside the Sac River valley. If these pseudo heat-treated artifacts are excluded, less than 6% of Burlington biface flakes ex-

Table 9.12. Heat Treatment of Bifacial Tools and Flake Debitage by Component.

	Heat Treated		Not Heat Treated		Total	
	N	%	N	%	N	%
Woodland/Mississippian						
Bifacial tools	11	64.7	6	35.3	17	100.0
Flake debitage	24	26.4	67	73.6	91	100.0
Woodland						
Bifacial tools	21	84.0	4	16.0	25	100.0
Flake debitage	3	37.5	5	62.5	8	100.0
Woodland/Late Archaic						
Flake debitage	32	24.6	98	75.4	130	100.0
Late Late Archaic						
Bifacial tools	6	100.0			6	100.0
Middle Late Archaic						
Bifacial tools	11	100.0			11	100.0
Flake debitage	308	50.9	297	49.1	605	100.0
Early Late Archaic						
Bifacial tools	5	19.2	21	80.8	26	100.0
Flake debitage	13	33.3	26	66.7	39	100.0
Middle Archaic						
Bifacial tools			2	100.0	2	100.0
Flake debitage			9	100.0	9	100.0
Late Early Archaic						
Bifacial tools	2	33.3	4	66.7	6	100.0
Flake debitage	5	20.8	19	79.2	24	100.0
Early Early Archaic						
Bifacial tools	2	20.0	8	80.0	10	100.0
Flake debitage	14	4.0	338	96.0	352	100.0
Late Paleoindian						
Bifacial tools	1	1.0	104	99.0	105	100.0
Biface flakes	117	3.7	3050	96.3	3167	100.0
Early/Middle Paleoindian						
Bifacial tools			5	100.0	5	100.0
Flake debitage	6	1.2	510	98.8	516	100.0
Pre-Clovis						
Flake debitage			5	100.0	5	100.0

hibit heat-treated attributes. Like their Early/Middle Paleoindian predecessors, Late Paleoindian knappers rarely if ever intentionally heat-treated chert. Only one of over 100 Late Paleoindian bifaces exhibit signs of thermal alteration (Table 9.12), and none of the Dalton or San Patrice diagnostic artifacts have been heat treated.

The lack of heat treatment has been noted at other Dalton sites in the Midwest. For example, none of over 100 Dalton adzes from northeast Arkansas were identified as thermally altered (Morse and Morse 1983:75). Collins et al. (1983:41–43) reported that only one of 39 Dalton points from the Montgomery site was heat treated. My analysis of the Montgomery Dalton points, however, revealed that none of them had been intentionally heat treated. Kay (1982e:497–500) reported that eight (44.4%) of the Dalton points from Rodgers Shelter had been heat treated prior to manufacture; however, an examination of the same specimens by the author revealed that none had been thermally altered (Table 9.13). This discrepancy is due in part to the high luster that Jefferson City chert exhibits in its raw or natural form; this appearance can be easily mistaken for the effects of heat treatment. A general absence of heat treatment (<5%) has also been noted in a survey of more than 300 Dalton points from the Central Mississippi River valley (Brad Koldehoff, personal communication 1998).

Early Early Archaic

Early Early Archaic artifacts exhibit only a slightly higher incidence of thermal alteration than Late Paleoindian artifacts. Debitage heat treatment ranged from a low of 4.2% in Jefferson City chert to a high of 8.6% in Burlington chert. Only two of 10 bifaces (20%) and one of nine projectile points/knives (11.1%) had been heat treated. The thermal alteration of chert may have first appeared as an intentional part of the lithic tool manufacturing strategy during early Early Archaic times; however, it does not appear to have become a particularly common or widespread technology until the latter part of the Early Archaic period.

Late Early Archaic

Although sample size is relatively small, the percentage of thermally altered artifacts increases significantly in the late Early Archaic assemblage (Tables 9.8 and 9.12). Over 20% of the flake debitage and one-third of the late Early Archaic bifaces exhibit evidence of heat treatment. Of 11 diagnostic points representing five separate types, over one-third were heat treated. Based on this small sample of diagnostic artifacts, there are preliminary indications that thermal alteration may have been restricted to certain late Early Archaic point types. In other words, it is possible that some late Early Archaic knappers were experimenting with this new technological innovation while others were not. This observation is supported by a recent examination of Searcy, Hidden Valley, Rice Lobed, and Graham Cave projectile points/knives from Rodgers Shelter that are curated at the Illinois State Museum (Table 9.13). Approximately 60% of the Searcy and Hidden Valley points had been thermally altered, whereas Rice Lobed and Graham Cave points exhibit little or no evidence of thermal alteration.

Early Late Archaic

Smith-Etley knappers practiced heat treatment on a regular basis, but the heat treatment appears to have been applied selectively according to chert type. For example, approximately 40% of the Burlington chert artifacts exhibit heat-treated attributes, whereas none of the Jefferson City chert artifacts were thermally altered. This is a reflection of the relative knapping qualities of the two resources in their natural form. It is interesting that early Late Archaic flake debitage shows a higher incidence of thermal alteration than bifaces (Table 9.12). A very low incidence of heat treatment (5.6%) was also noted in a sample of Smith Basal Notched points (dominated by Jefferson City chert) from Rodgers Shelter (Table 9.13).

Middle Late Archaic

The highest incidence of thermal alteration at the Big Eddy site is associated with the Williams component. Over one-half of the Williams assemblage, which is made up almost exclusively of Burlington chert, exhibits evidence of heat treatment. The small amount of Jefferson City chert utilized, on the other hand, was rarely heat altered. Heat treatment was applied to Burlington chert artifacts in the middle to late stages of lithic reduction, either as primary bifaces or as secondary bifaces, and quite possibly during both stages of the reduction sequence. All 11 biface fragments and all six projectile points/knives recovered from the Williams

Table 9.13. Heat Treatment at Rodgers Shelter.

	Heat Treated					Not Heat Treated						
	Jefferson City Chert	Burlington Chert	Chouteau Chert	Total		Jefferson City Chert	Burlington Chert	Chouteau Chert	Total		Total	
Point Type	N	N	N	N	%	N	N	N	N	%	N	%
Dalton						10	6	1	17	100.0	17	100.0
Searcy	20	4	1	25	61.0	15	1		16	39.0	41	100.0
Hidden Valley	19	3	1	23	57.5	17			17	42.5	40	100.0
Rice Lobed	1	1		2	25.0	6			6	75.0	8	100.0
Graham Cave						8			8	100.0	8	100.0
Smith	1	1		2	5.6	28	4	2	34	94.4	36	100.0
Kings	14	3		17	63.0	8		2	10	37.0	27	100.0

Note: Heat-treatment identifications made by the author.

component were heat treated. Thermal alteration was clearly an integral part of manufacturing Williams points and other bifacial tools, and it was necessitated by the exploitation of a relatively low-grade, coarse- to medium-grained raw material.

Woodland/Late Archaic

The mixed Woodland/Late Archaic assemblage shows a marked decrease in thermal alteration compared to the Williams component. Nevertheless, one-quarter of the assemblage exhibits attributes of heat treatment. As seen in most of the other component assemblages, there is a significant difference in the frequency of heat-treated Burlington chert compared to Jefferson City chert. This has been documented repeatedly in southwest Missouri (McGrath et al. 1988:79; Ray 1995c:134–135, 1996:101, 1997:41–43; Ray and Benn 1991:45) and is related to the texture and knapping quality of each raw material.

Woodland

The Woodland data are heavily skewed toward heat treatment because most (75.8%) of the Woodland artifact total is composed of projectile points recovered from the stripped surface and cutbank. The Woodland data cannot be compared directly with the other components, which are derived predominantly from the analysis of flake debitage. Of 28 Woodland points found at the Big Eddy site, 85.7% were thermally altered. It appears that heat treatment was an important step in the manufacture of bifaces in Woodland times. Thermal alteration apparently was an integral part of the manufacture of Kings Corner Notched dart points since all 18 Kings points from the Big Eddy site were thermally altered. Over 60% of Kings points from Rodgers Shelter also exhibit heat treatment (Table 9.13).

Woodland/Mississippian

Approximately one-third of the Woodland/ Mississippian chert artifacts were heat treated. A comparison of heat treatment by chert type reveals that Burlington chert was twice as likely to have been thermally altered as Jefferson City chert (Table 9.11). As expected, Woodland/Mississippian bifaces exhibit a much higher incidence of heat treatment than does the flake debitage (Table 9.12). Three-quarters of the most common arrowpoint type, Scallorn Corner Notched, exhibit heat-treatment attributes.

SUMMARY AND CONCLUSIONS

Investigations at the multicomponent Big Eddy site with stratified deposits, some of which occur in sealed contexts, has allowed a rare diachronic analysis of raw-material procurement and selection at a single study locale. The lower Sac River valley exhibits a variety of fair to high-quality raw materials with differential access and availability, which allowed the development of a variety of lithic-exploitation strategies. The most instructive information regarding local resource procurement and exploitation is obtained from analyzing lithic waste debris and manufacture failures and rejects, preferably from an undisturbed workshop or midden area. Lithic workshops were functionally specific activity areas and were geared toward the reduction of large quantities of raw material. The knapping of large quantities of heavy chert implies direct procurement from nearby local sources. Finished tools such as projectile points/knives, drills, and hafted scrapers, on the other hand, are highly mobile (curated) artifacts that may or may not have been manufactured from local materials. The best data on local resource exploitation at the Big Eddy site, therefore, are from the well-defined workshop areas and/or midden deposits. Conversely, the best data on the procurement and movement of exotic raw materials were obtained from finished, curated tools.

Although the limited 1997 excavations at Big Eddy provided an unexpected wealth of lithic information on some time periods, data on other periods are sorely lacking. The best interpretive data were obtained from excavated contexts in some of the deepest deposits that correlate with Early/Middle Paleoindian, Late Paleoindian, early Early Archaic, and middle Late Archaic times. More information on other periods such as late Early Archaic, Middle Archaic, early Late Archaic, late Late Archaic, and Woodland should be a focus of future investigations.

Local Resources

Five types of chipped-stone resources were locally available to inhabitants of the Big Eddy site. Two of these, Warner chert and Jefferson City

quartzite, were used only incidentally due to limited knapping quality and scarce availability. The three major chert resources utilized were Jefferson City, Burlington, and Chouteau. Procurement of these local resources was direct. The local availability of these three cherts in bedrock and residual deposits is highly variable: Burlington chert occurs in the greatest quantities and is most easily accessible, whereas Jefferson City occurs in the smallest quantities and is least accessible. All three cherts were immediately available in gravel deposits of the Sac River, but the quantity of each resource was also highly variable. For example, Burlington chert comprises over 80% of all knappable cobbles in the Sac River, whereas Jefferson City chert makes up less than 15%, and Chouteau chert comprises only approximately 1%. Based on tests of late Pleistocene and modern gravel-bar deposits, relative percentages of the three major chert types remained constant from Early Paleoindian to modern times.

A diachronic analysis reveals that the procurement and use of local chert resources at the Big Eddy site changed significantly through time (Figures 9.2, 9.4, and 9.5). These differences appear to be linked primarily to changing lithic technologies, procurement strategies, and possibly settlement (mobility) patterns. During early prehistoric times (i.e., Early/Middle Paleoindian, Late Paleoindian, and early Early Archaic), the procurement and use of lithic resources was relatively consistent. Jefferson City chert was the predominant or primary resource utilized, comprising 80% or more of each assemblage. Although the bulk of the Late Paleoindian assemblage (i.e., debitage) cannot be differentiated by component, diagnostic and potentially diagnostic Dalton and San Patrice tools indicate that Jefferson City chert was the preferred resource for both Dalton and San Patrice knappers.

A closer look at Jefferson City chert indicates differential use or selection among the six varieties of this high-quality resource. The Ellipsoidal variety of Jefferson City chert was the preferred variety during all three early prehistoric periods, although its use decreased from a high of 61% during the Early/Middle Paleoindian period to about 38% during early Early Archaic times. Banded Jefferson City chert was the secondmost utilized variety of Jefferson City chert, and the other varieties contributed relatively minor amounts. Although a preliminary observation based on tentative cultural affiliation of certain knapping features, it appears that Dalton knappers used a slightly higher percentage of Banded Jefferson City chert than San Patrice knappers. In general, Ellipsoidal Jefferson City chert exhibits the highest quality of all six varieties. Indeed, pound for pound it is the highest quality chipped-stone raw material in the northern Ozarks (Ray 1998), and it is equal in quality to Lower Reeds Spring chert, which is the finest chert resource in the southern Ozarks (Ray 1984:238). Ellipsoidal Jefferson City chert is very fine grained (glass-like) and contains few internal flaws; it occurs in thin, ellipsoidal nodules that serve as natural preforms (Figure 9.6). A preference for high-quality cryptocrystalline material by Paleoindian and Early Archaic knappers has been noted repeatedly (e.g., Goodyear 1989; Haynes 1980, 1982; Meltzer 1985; Smith 1990; Tankersley 1989, 1990, 1991). It is probably no accident that an unusually high percentage of fluted points and Dalton points have been recently noted in private collections from the Sac River valley compared to neighboring areas.

Among the other local chert resources, Chouteau chert and Burlington chert were consistently present, but in relatively minor quantities. Chouteau chert comprised approximately 8–11% and Burlington chert about 5–10% of early prehistoric assemblages. When the relative availability of the two cherts are considered, however, it is evident that Chouteau chert was preferred over Burlington chert. Chouteau chert occurs in very small quantities in the river gravels, and residual deposits of Chouteau chert occur at much greater distances (1.4+ km). Therefore, although the utilization percentages are roughly equal, a much greater effort was made to obtain Chouteau chert than Burlington chert.

In addition to having a strong preference for certain high-quality raw material, Early/Middle Paleoindian, Late Paleoindian, and early Early Archaic knappers were also highly selective about where they procured their raw material since approximately 80–84% of each assemblage was procured from alluvial sources. Visual tests and reconnaissance surveys of local gravel bars reveal that early prehistoric knappers would have had little trouble finding high-quality chert cobbles (e.g., Ellipsoidal Jefferson City chert) among the expansive gravel deposits in the Sac River. Although Late Paleoindian knappers exploited primarily alluvial sources, it is important to note that a significant percentage of Chouteau chert and Banded Jefferson City chert was also procured from residual sources. This implies a greater familiarity with the local

Figure 9.6. Ellipsoidal Jefferson City chert. Top: natural preform-like ellipsoidal cobbles with cortex. Bottom: interior flakes exhibiting banded, mottled, and homogeneous internal structure.

landscape than their Early/Middle Paleoindian predecessors and the discovery of highly localized residual deposits of these two resources. In addition, the intensive procurement and use of stream-deposited cobbles of Jefferson City chert (especially the Ellipsoidal variety) by Late Paleoindian knappers may have depleted this relatively scarce commodity (at least locally), creating an incentive to find alternative (i.e., residual) sources.

There appears to have been little if any intentional thermal alteration of chert during Paleoindian times. Most of the thermal alteration observed in these assemblages was probably due to accidental exposure to fire. The earliest intentional heat treatment of chert possibly occurred during early Early Archaic times, but it was still rare.

Although tentative due to small sample size, the first major changes in resource procurement and use at the Big Eddy site appear to have begun sometime during late Early Archaic times when Burlington chert replaced Jefferson City chert as the primary resource. Jefferson City chert became a secondary resource with little if any selection among the six varieties. Although sample size is small, there also appears to have been a shift to procuring the majority of chert from residual deposits rather than alluvial deposits. Intentional thermal alteration of chert was clearly established by late Early Archaic times. Nevertheless, it was probably restricted to certain affiliated knappers who were experimenting with early heat-treatment technology.

Very little Middle Archaic material was recovered during the 1997 investigations, but it is probable that the procurement and use of Burlington chert from residual sources increased as did the incidence of thermal alteration. This general exploitation pattern continued into the Late Archaic period with some variations according to specific cultural component. Approximately three-quarters of the Smith-Etley assemblage was composed of Burlington chert, most of which was procured from nearby ridge slopes. Predominant procurement from residual sources was intentional since large quantities of Burlington chert were readily available in Sac River gravels. Late Archaic chert procurement and selection appears to reflect changing procurement strat-

egies and lithic technologies. This may have been a function of reduced residential mobility during the mid Holocene (Stafford 1994). Resource utilization became more focused on the most easily accessible and abundant raw material (i.e., residual Burlington chert) regardless of quality, and technologies changed to the production of large, heavy-duty cutting tools that could be more easily manufactured from large, residual boulders than smaller (alluvially reduced) stream cobbles. Smith-Etley knappers appear to have heat treated some of their chipped-stone raw material, although rather selectively according to chert type.

The greatest selection or preference for any one chert resource was made by Williams component knappers, who focused on Burlington chert (95%) to the near exclusion of other local resources. For the first and apparently only time, high-quality Jefferson City chert was relegated to a minor, almost incidental, resource. Procurement of Burlington chert continued to be predominantly from local residual sources. The highest incidence of thermal alteration is associated with the Williams component; the heat-treatment techniques applied to Burlington chert in this assemblage were so effective that its quality was increased nearly to the level of Jefferson City chert. Practically all Williams bifaces were subjected to thermal alteration, perhaps repeatedly, in the intermediate to late stages of biface production. Unfortunately, no debitage was collected from the late Late Archaic Afton-Castroville component; however, several hafted bifaces suggest procurement was also highly focused on Burlington chert and that heat treatment was applied to a high percentage of bifaces.

More debitage needs to be obtained from good Woodland contexts (i.e., deep, stratified late Rodgers Shelter submember) to ascertain strategies of lithic procurement and use. The available data, obtained primarily from projectile points (especially Kings points), suggest a continued primary reliance on Burlington chert (although less than during Archaic times) but with a slight increase in the use of Jefferson City and Chouteau cherts. Preliminary data indicate that the incidence of heat treatment was probably less than that undertaken during the Williams occupation but more than that evident in the Smith-Etley component.

Unfortunately, the 1997 investigations could not isolate late-prehistoric components (i.e., Woodland, Late Woodland, and Mississippian) and associated chert-exploitation strategies. The collective data, however, indicate that Burlington chert was the primary resource exploited and that Jefferson City chert was an important supplemental resource. The cortical data suggest a return to a primary reliance on alluvial chert for the first time in approximately 5,000 years. This may reflect a shift in lithic technology from large (Late Archaic) hafted bifaces to smaller dart points and arrowpoints, which could be easily manufactured from an inexhaustible supply of river cobbles. Heat treatment may have declined compared to earlier periods; however, it is still evident in approximately one-third of the Woodland/Mississippian assemblage. Woodland/Mississippian knappers also may have been selectively heat treating their raw materials since twice as much Burlington chert was thermally altered as Jefferson City chert.

Exotic Resources

The Big Eddy site is located in a geologic edge area that is rich in lithic resources. This edge area, called the Springfield Plateau, contrasts with the Salem Plateau to the east and the Osage Plains to the west, where high-quality resources are few or entirely absent. Multiple types of chert occur in great abundance along the Springfield Plateau (western Ozarks border); this situation provides an excellent opportunity to investigate raw-material trade or exchange vs. embedded and/or direct procurement. Indeed, the Sac River valley may well have been a staging area for the transportation of high-quality raw materials to the neighboring lithic-poor areas, but there was no need to import cherts into the study area since abundant quantities of high-quality resources were present. It is reasonable to assume, therefore, that any exotic raw materials found at Big Eddy are a result of interregional trade or long-distance seasonal (embedded) procurement and curation. It is very difficult, however, to determine the exact mode by which exotic chert artifacts arrived at the site.

Archaeologists have grappled with this problem for several decades. As Meltzer (1989:30) stated, "the unfortunate bottom line is that there do not seem to be clear cut rules for sorting direct from indirect acquisition in any deterministic fashion." He goes on to note, however, that in two narrow circumstances, it might be possible to tentatively reject one form of acquisition in favor of another: (1) in cases where an assemblage is composed entirely of exotic raw material, exchange may be rejected,

and (2) in cases where exotic stylistic attributes are present, it is reasonable to reject direct procurement (Meltzer 1989:30). Neither is the case at Big Eddy. It appears impossible, therefore, to conclusively demonstrate which form of acquisition (i.e., direct or indirect) is represented by the Big Eddy exotic chert artifacts. Indeed, it is probable that both forms of acquisition are represented. Nevertheless, I believe it is appropriate to examine artifact attributes and other related information to arrive at tentative conclusions that may indicate which form of acquisition was dominant.

As expected in a chert-rich area, exotic raw materials at the Big Eddy site account for a very small minority of the chipped-stone artifacts from any one time period. Nevertheless, they were often present, especially in the earliest assemblages. The largest number (n=37) and greatest variety of exotic cherts were found in the Late Paleoindian horizon. These exotic cherts can be separated into two basic groups: Mississippian cherts located in the southwestern Ozarks and Pennsylvanian cherts located in the Osage Plains. Based on the presence of these exotic artifacts, it is clear that the Late Paleoindian groups had established ties (directly or indirectly) with the upper White River valley area to the south and southwest and with the eastern Plains area to the west and northwest (see Ballenger 1998 for similar Late Paleoindian interaction along the prairie-woodland border in eastern Oklahoma).

The exotic Mississippian cherts would have been transported to the Big Eddy site via an overland route since all four cherts are located well south of the Ozark Divide. Nearly one-third of these exotic artifacts are formal tools (e.g., projectile points/knives, scrapers, and flake knives), and the remainder consist of late-stage reduction flakes, probably resharpening flakes from curated tools. Indeed, at least four exotic chert end scrapers had been resharpened to exhaustion. Perhaps the best indicators of curation behavior are the two flake knives knapped from Red Pierson chert. Informal flake tools are very easy to replicate, negating any need for long-distance transport unless they were already incorporated into a mobile tool kit or were particularly valued aesthetically for their unusual red coloration. For these reasons (e.g., relatively small quantity of a variety of finished/recycled utilitarian tools made from multiple exotic chert resources), it is probable that the majority of the exotic Mississippian chert artifacts arrived at the Big Eddy site as a result of band mobility or embedded direct procurement, i.e., they represent curated artifacts obtained from the upper White River valley during periodic seasonal movements. If exchange had been the dominant means of acquisition, then a larger quantity of unfinished preforms made from a more restricted selection of chert resources, as well as the presence of nonutilitarian tools, might be expected.

Foraging mobility of Dalton and other Late Paleoindian hunter-gatherers has been discussed at length by several researchers (Anderson 1995a; Anderson and Sassaman 1996; Morse 1971; Schiffer 1975; Walthall 1998a; Walthall and Holley 1997). Late Pleistocene hunter-gatherers may have been highly mobile foragers following an annual round, and they may have carried highly curated task-specific tool kits (Walthall 1998a:2–3). One such Dalton tool kit, the Lembke cache found in the uplands of southwestern Illinois, contained 10 tools: one Dalton point, one adze, six end scrapers, and two flake knives (Walthall and Holley 1997:155). Tools of all of these types, except adzes, were made from exotic cherts at Big Eddy.

It is very difficult to assign cultural affiliation (Dalton vs. San Patrice) to most of the Late Paleoindian exotic Mississippian chert artifacts found at the Big Eddy site, especially those found in the middle and upper portions of the 3Ab horizon where both components occur. It is tempting to associate some of the southernmost exotic cherts (i.e., Pitkin and Middle Reeds Spring) with occasional visits by San Patrice migrants from the south, but Dalton groups were no strangers to the Boston Mountains area. Indeed, it is probable that Dalton sites greatly outnumber San Patrice sites in northwest Arkansas. At least one artifact, the Dalton point made from Lower Reeds Spring chert in the Dan Long collection, establishes a connection between the Dalton component and exotic cherts from the upper White River valley. Additionally, if the observation that only the Dalton component is represented in the lower portion of the 3Ab horizon is accurate, then two resharpening flakes recovered from Level 32 associate the Dalton component with Pitkin chert and Lower Reeds Spring chert.

The exotic Pennsylvanian chert artifacts were less common but no less interesting. One formal tool (end scraper), two flake fragments, and one broken secondary biface were made from these cherts. At least three different chert resources are represented. The end scraper and two flake fragments probably represent a curated tool and re-

sharpening flakes from curated tools. The largest flake fragment exhibits light polished areas at the distal end, which suggest it is an adze resharpening flake. The other exotic Pennsylvanian chert specimen is more problematic; in fact, it represents the best case for possible Late Paleoindian trade of exotic raw materials. This secondary-biface fragment (Figure 9.3i), knapped from the Reeds variety of Winterset chert, is a Dalton preform that failed during lateral thinning at the Big Eddy site. From a curation standpoint, it seems impractical to transport a preform over 130 km (especially to a chert-rich environment) only to risk failure during the final stages of manufacture, unless it was a trade item (see Tables 8.9 and 8.18 for large number of Late Paleoindian preform failures). Evidence for Early Paleoindian long-distance exchange of high-quality raw materials has been presented in a number of studies (Anderson 1995a; Hester and Grady 1977; Hayden 1982; Tankersley 1989, 1991). Recently, Walthall and Koldehoff (1998) make a case for Late Paleoindian (Dalton) long-distance trade of large (ceremonial) Sloan points made from high-quality Burlington chert in the Central Mississippi Valley. They posit increasing territoriality and population size, resulting in the intensification of interaction between neighboring groups, and ultimately the establishment of alliance networks (including trade) to mitigate interband discord.

Although the Dalton preform made from Winterset chert is probably not a ceremonial exchange item, it could easily represent interregional trade between neighboring groups on the western Ozarks border to establish, maintain, and/or strengthen sociopolitical ties. The importation of an inferior exotic chert into an area with abundant high-quality resources was certainly unnecessary unless reciprocity was an intended result. It is even conceivable that Big Eddy may, at one point, have served as a meeting place or rendezvous site where various local and nonlocal Late Paleoindian groups merged to exchange local and exotic raw materials and other commodities. At a minimum, the extensive workshop area at Big Eddy provides evidence of major retooling activities (by at least two and possibly three contemporary groups) and could represent a staging area for the production of high-quality chert tools for exchange to chert-poor outlying areas. Such a staging area would be strategically suited for aggregation events (Anderson 1995a:13). Nevertheless, curation of the Winterset preform cannot be ruled out. Although unlikely, it is possible that a hiatus in Dalton occupancy of the Sac River valley for several generations created an absence of knowledge of the high-quality resources in the valley. This may have resulted in the production of preforms at the Winterset source area to be carried east into areas with unknown resources.

The above exotic Pennsylvanian cherts could have been transported to the site by an overland route; however, they could also have arrived by a riverine route (e.g., down the Marais des Cygne and Osage rivers and up the Sac River), most of which would have been downstream. Such a river route would make the eastern transport of unfinished stone artifacts easier and the potential for trade more plausible, assuming Dalton people made dug-out canoes (Morse and Goodyear 1973). The Marais des Cygnes River penetrates well into eastern Kansas and into the outcrop areas of most of the exotic Pennsylvanian cherts described herein.

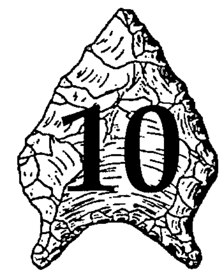
The final Late Paleoindian exotic chert artifact found at the Big Eddy site is the Wilson projectile point/knife. Positive identification has not been made, but the material strongly resembles Johns Valley chert found in the western Ouachita Mountains (southeast Oklahoma). If manufactured from Johns Valley chert, it would represent the most distant resource found at the Big Eddy site (approximately 400 km southwest of the project area). It is unclear whether this exotic chert artifact represents long-distance curation or exchange.

In sum, most of the Late Paleoindian exotic chert artifacts may reflect considerable mobility in north-south and east-west directions. If we accept that the majority of these exotic chert artifacts at the Big Eddy site represent embedded direct procurement and curation, then Late Paleoindian band range(s) was at least 110-200 km north-south and probably a comparable distance to the west and/or northwest. Similar distances (approximately 100–200 km) have been postulated for linear-shaped Late Paleoindian (Dalton) band territories in northeast Arkansas (Morse and Morse 1983:Figure 4.1). As might be expected, these band ranges/distances are less than those routinely traversed by Early/Middle Paleoindians, i.e., 150–300 km or more (Goodyear 1989:5; Haynes 1982:392; Meltzer 1989:11; Simons et al. 1984:267), but they still are indicative of considerable movement of Late Paleoindians along the Plains-Ozarks border. Exchange practices also probably contributed to the mix of exotic raw materials at Big Eddy. At least one broken

preform of Winterset chert offers some tantalizing evidence of trade between Dalton groups in the eastern Plains and the western Ozarks.

Based on Lower Reeds Spring and Pitkin chert artifacts, Middle Paleoindian and early Early Archaic residents at Big Eddy also had ties to high-quality chert resources in the southwestern Ozarks, probably via seasonal rounds. Early Graham Cave knappers apparently retained some ties to the eastern Plains area as well. Finally, one curated artifact (a projectile point/knife) knapped from exotic chert was found in the early Late Archaic assemblage and one was found in the Woodland assemblage. The Smith point made from Lower Reeds Spring chert indicates a connection with source areas to the south, whereas the Waubesa point manufactured from Florence B chert indicates a connection with source areas to the west.

ANALYSIS OF FLOTATION SAMPLES



Neal H. Lopinot

Plant remains and other systematically recovered small-scale debris had not been analyzed for any archaeological sites in the middle and lower Sac River valley prior to the Big Eddy investigations. Large-scale salvage excavations in Stockton Reservoir were undertaken before flotation sampling had gained a position in the standard repertoire of field procedures, and no large-scale excavations have been undertaken in the Sac River valley since the late 1960s. Excluding the studies of plant remains from Rodgers Shelter and Phillips Spring in the nearby lower Pomme de Terre valley (Kay et al. 1980; King 1982b; Parmalee et al. 1976), and more recently from a few other sites in southwest Missouri (e.g., Lopinot 1995; Lopinot and Fadler 1996), the record for this region is generally poor or nonexistent for most periods of prehistory.

Intensive excavations at the Big Eddy site have afforded great potential for systematically analyzing changing patterns of human-plant relations from Paleoindian to Mississippian times. A relatively large number of flotation samples was collected and processed. Much has been learned about plant-procurement activities in the lower Sac River valley during a few periods of prehistory, but the evidence for others is scant. Continued excavations at the site should provide a much richer record of human-plant relations, and the results of this analysis should help guide subsequent investigations of the site, particularly in regards to the recovery of plant materials from the earliest deposits.

METHODS

A total of 123 flotation samples was collected from the Big Eddy site during the 1997 field season. These consist of: (1) 42 samples from 40 features; (2) 10 samples from TU 1, located along the west wall of Trench 1; (3) three samples from TU 2, located in the south wall of Block A; (4) 14 samples from the west wall of TU 5 in Block A; (5) 48 samples from the east wall of Block B and the south wall of Block C; and (6) six miscellaneous samples from various proveniences. In addition to these flotation samples, numerous hand-collected materials, specifically of carbonized materials, were obtained during the course of the investigations.

The archaeological sediments comprising the flotation samples were poured into 0.3-mm-mesh nylon bags and then gently agitated and squeezed while a steady stream of water flowed across and permeated the bags. After the clay to medium sand particles had filtered through the mesh, the samples were air-dried on newspaper-lined beer flats. This process results in sediment-cleaned (except for very coarse sand) samples with no separation of heavy and light fractions. There are two important aspects of this procedure that should be noted. First, there is no opportunity for cross-sample contamination during the process. The bags are tied shut with only fine particles (i.e., less than 0.3 mm) and water moving through the nylon mesh. Second, despite efforts to be gentle, the squeezing of the bags and the presence of larger, heavier materials does result in some damage (i.e., fragmentation). This is compensated for by the fact that virtually all identifiable materials are retained in the samples.

All chipped-stone materials were sorted, counted, and weighed for two different size fractions: ≥2.0 mm and 1.0–2.0 mm in size. The sorting of such materials was undertaken to assist in defining cultural and noncultural deposits, to determine the density of lithic debris in various archaeological

contexts, and to help in evaluating the postdepositional translocation of debris.

All plant remains ≥2.0 mm in size were sorted, counted, and weighed according to general material classes (e.g., wood charcoal, bark, etc.) for all Woodland/Mississippian and Late Archaic samples. Counts and weights were obtained for each material class per sample using a top-loading Ohaus electronic balance. Materials that weighed less than 0.005 g were noted as having trace (T) weights. Materials that passed through the 2.0-mm sieve were scanned for seeds and other carbonized materials found lacking in the larger sorted fractions. Occurrences of carbonized materials only in the residual fractions were noted on a presence (P) basis. The residual fractions consisted mostly of inorganic materials. An 8–40X stereozoom microscope was used for sorting, scanning, taxonomic analyses, and specimen measurements.

For samples derived from Early Archaic and Paleoindian deposits, all materials ≥1.0 mm in size were sorted, counted, and weighed. The residual fraction, composed of debris smaller than 1.0 mm, was also scanned for seeds and other materials lacking from the larger fractions. When no carbonized remains occurred in the ≥2.0-mm and 1.0-mm fractions, all charred plant remains greater than 0.5 mm in size were sorted. In addition to the sorting of plant remains and chipped-stone debris, considerable effort was made to locate any faunal materials (even calcined bits) in the Early Archaic and Paleoindian samples.

More detailed analyses were undertaken for wood charcoal and seeds. For the Woodland/Mississippian and Late Archaic samples, at least 20 wood fragments per sample (unless there were fewer) were subjected to taxonomic identification. All carbonized seeds, whether represented by whole specimens or fragments, also were examined. Whole seeds and fragments were counted and seed number estimates (SNEs) were generated based on the most common anatomical part represented for a particularly taxon. These SNEs consider each flotation sample as a separate entity.

Every effort was made to identify all sorted carbonized materials in the Early Archaic and Paleoindian samples. Owing to the paucity of carbonized materials, their typically small size, generally poor state of preservation, and the seminal importance of documenting Early Archaic and Paleoindian human-plant relations in the Midwest, a considerable amount of time was devoted to the identification of these materials. Still, there is much that can be undertaken in the future (e.g., scanning electron microscopy).

WOODLAND/MISSISSIPPIAN COMPONENT

At least 16 features were defined on the stripped surface at the Big Eddy site. Flotation samples (n=16) were obtained from 15 features, whereas burned wood was hand-collected from Feature 2, a large scatter of charcoal within a diffuse boundary. Other than Feature 2, these features were relatively small, difficult to define, sometimes irregular in vertical profile, and they contained no ceramics and relatively few lithic artifacts. As such, there was some question as to whether many of these features were cultural in origin. The analysis of flotation samples was undertaken partly to evaluate the cultural vs. noncultural origin of these features, as well as to determine the nature of late-prehistoric activities represented by debris in those features considered to be cultural.

Counts and weights for debitage and various types of plant remains are presented in Table 10.1 for the 15 flotation-sampled features. The total number of sorted plant remains was 4,905 (43.39 g). Based on the contents of the samples, three groups of features were defined: cultural, probable cultural, and noncultural (see Chapter 8). Besides consideration of the regularity or irregularity of the features in plan view and vertical profile, cultural features were defined based on the presence and number of flakes, as well as the heterogeneity of plant remains in flotation samples. The presence of several different taxa of wood charcoal, nut shell, and seeds of edible fruits (e.g., cherry pits and grape pips) was considered indicative of cultural deposits. An array of wood charcoal can be predicted for a fire containing fuel materials that were procured by relatively random collection of limbfall from a forest floor. Carbonized nut shell and relatively large fruit seeds also are common byproducts of food consumption.

The 11 features designated as cultural pits or post molds are Features 1–3, 6–9, 11, 12, 15, and 16. Those determined to be possible cultural pits or post molds are Features 10 and 13, whereas Features 4, 5, and 14 were considered to be noncultural. Feature 4 did contain an assortment of wood charcoal, but a few charcoal fragments were only partially carbonized and the sample contained an

Table 10.1. Sorted Plant Remains in Flotation Samples from Woodland/Mississippian Features.

	Feature 1		Feature 3		Feature 4		Feature 5		Feature 6		Feature 7		Feature 8		Feature 9	
Debris Class/Material Type	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)
Fuel/construction																
Wood charcoal	2	0.01	43	0.33	34	0.19	461	7.02	12	0.07	346	4.23	161	1.69	38	0.36
Bark	P		5	0.04			17	0.07	4	0.03	1	T	2	0.11	5	0.07
Twig			P						P		3	0.04				
Grass/herb stem			P													
Fungal					1,634	4.10			P				P			
Nut remains																
Hickory nut shell	P								1	T			2	0.03		
Walnut shell									1	0.02	4	0.19	1	0.02		
Juglandaceae nut shell									1	T	2	0.01			5	0.03
Acorn shell																
Hazelnut shell																
Indeterminate															1	0.01
Total	2	0.01	48	0.37	1,668	4.29	478	7.09	19	0.12	356	4.47	166	1.85	49	0.47
Sample volume (liters)	10.0		9.0		9.0		4.5		9.0		9.0		9.0		9.0	
Debitage (n)																
≥ 2.0 mm	11						1		2				1		1	
1.0–2.0 mm	32						2		9		1				2	

Table 10.1. Sorted Plant Remains in Flotation Samples from Woodland/Mississippian Features. (Continued).

Debris Class/Material Type	Feature 10 N	Feature 10 Weight (g)	Feature 11 N	Feature 11 Weight (g)	Feature 12 N	Feature 12 Weight (g)	Feature 13a N	Feature 13a Weight (g)	Feature 13b N	Feature 13b Weight (g)	Feature 14 N	Feature 14 Weight (g)	Feature 15 N	Feature 15 Weight (g)	Feature 16 N	Feature 16 Weight (g)
Fuel/construction																
Wood charcoal	527	8.27	3	0.20	22	0.19	86	0.60	81	1.02	117	1.85	52	0.58	38	0.56
Bark	15	0.11			1	T	30	0.15	26	0.26			1072	10.64	1	T
Twig	2	0.01											1	0.01		
Grass/herb stem																
Fungal			P				P		7	0.02						
Nut remains																
Hickory nut shell																
Walnut shell	1	0.01			4	0.05									1	0.01
Juglandaceae nut shell					6	0.06									P	
Acorn shell			P						1	T						
Hazelnut shell			1	T												
Indeterminate							14	0.15								
Total	545	8.40	4	0.20	33	0.30	130	0.90	115	1.30	117	1.85	1135	11.23	40	0.57
Sample volume (liters)	9.0		9.0		9.0		9.2		9.0		8.5		9.0		9.0	
Debitage (n)																
≥ 2.0 mm			1				1						3		1	
1.0–2.0 mm	1		3				2						15		4	

abundance of saprophytic fungal tissues (most carbonized, but some partially carbonized and some humified) indicative of decomposing plant tissues. The vertical profile was irregular and not unlike that for a root mold, and debitage, nut shell, and seeds were lacking in the flotation sample. The samples from Features 5 and 14 contained only maple wood charcoal. The Feature 5 sample contained a few pieces of debitage, but no carbonized nut shell or seeds, whereas the Feature 14 sample contained one fragment of a lamb's quarter seed, no debitage, and no nut shell. Although many species of chenopod or lamb's quarter produce edible greens and seeds, they are also common weeds and can be found today at the Big Eddy site where cattle have not grazed heavily.

A total of 2,642 specimens, weighing 30.19 g, was sorted, counted, and weighed for the 2.0-mm fractions of samples from cultural and possible cultural features. Fuel/construction materials dominate this assemblage, with wood charcoal and bark comprising 1,411 specimens (18.11 g) and 1,162 specimens (11.41 g), respectively. Except for Feature 15, wood charcoal is the dominant material in all of the samples. Ten of the 11 cultural and possible cultural features (i.e., again excluding Feature 15) also contain scant amounts of nut shell. There were three feature samples with hickory nut shell, seven with black walnut shell, two with acorn shell, and one with a tiny fragment of hazelnut shell. Combined, the sorted nut shell amounts to only 31 fragments weighing 0.43 g.

The wood charcoal in at least three, and perhaps four, of the cultural features indicates the burning of one species of wood, such as might be expected for the base of a post or a fire made from one or more limbs from a single tree or trees of one species. Feature 2 is represented only by maple wood charcoal, whereas Features 7 and 8 (both interpreted as pit features) contain only walnut wood charcoal. Although Feature 13 exhibited a variety of wood taxa overall, the two samples from this possible post mold are quite distinctive. One sample (Feature 13b) contained only walnut wood charcoal and no seeds, whereas the other sample (Feature 13a), possibly representing refuse materials packed around the base of the post, contained specimens representing a variety of wood and seed taxa.

The identified wood charcoal taxa in the 11 cultural and probable cultural features are indicative of relatively rich and diverse floodplain forests or woodlands (Table 10.2). Assuming that wood collection was relatively random, it can be inferred that the primary trees in the late-prehistoric floodplain apparently consisted of oak, hickory, walnut, maple, and ash. The relative abundance of walnut and the presence of other shade-intolerant species such as cottonwood/willow, cherry/plum, and sassafras may indicate that the timber was relatively open, or at least there were many sunlit openings in the local forests.

Feature 15 is dominated by bark fragments. Based on its size, its basic shape, the absence of burned earth indicative of heating in an oxidizing atmosphere, and the great abundance of charred bark, this feature is regarded as a smudge pit. Although maize cobs were the preferred materials for use in the smudging of hides and pots during historic times, bark also was often used (see Binford 1967, 1972; Munson 1969). The absence of any evidence for cultivational activities by the late-prehistoric occupants of the Big Eddy site implies that maize cobs would not have been available for use in smudging. Conversely, bark and rotted wood would have been readily available and probably constituted the preferred material for smudging. The paucity of ceramics and the relative abundance of late-prehistoric dart and arrowpoints on or near the surface further implies use for hide smudging by a hunting party or a group of seasonally temporary residents.

A total of only 35 seeds is represented in the samples (Table 10.2). Only two taxa, both plants that produce fleshy fruits, are considered to represent probable food residues. These consist of cherry and wild grape. The remainder perhaps represent fortuitously carbonized seeds present in the soil seed bank or else seeds that were little more than nuisances (bedstraw and avens) that were picked from clothing and tossed into fires. Occurrences of seeds of common ragweed, lamb's quarters, bedstraw, white avens, stargrass, knotweed, and dock all point to disturbed habitats, such as open river banks, old fields, open camp sites, and disturbed forest floors with sunlit openings.

In summary, the archaeobotanical evidence indicates that late-prehistoric people probably used the Big Eddy site as an extractive locus for relatively brief periods of time. The abundance of hunting tools, the low number of features, the complete absence of milling equipment in the late-prehistoric deposits, the absence of domesticated plant remains and digging equipment, and the general paucity of plant-food remains relative to fuel mate-

Table 10.2. Identified Wood Charcoal and Carbonized Seeds from Woodland/Mississippian Features.

Taxa[a]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Identified wood																
Quercus spp. (white oak group)	1								2			1	2			
Quercus spp. (red oak group)			1	1									13		13	
Quercus spp. (indeterminate oak)			2						1				1		1	
Carya spp. (true hickory)						7			17						2	20
Acer spp. (maple)		40		7	20									20		
Fraxinus spp. (ash)				1		2							2			
Gleditsia/Gymnocladus (locust/coffeetree)						2							2		4	
Juglans spp. (walnut)			16				20	20			1	14	20			
Prunus cf. *serotina* (cherry/plum)										20						
Ulmaceae (hackberry/elm)				1								2				
Salicaceae (cottonwood/willow)			1													
Sassafras albidum (sassafras)												1				
Ring porous				1							1					
Diffuse porous												1				
Indeterminate				9							1	2				
Identified carbonized seeds																
Ambrosia cf. *artemisiifolia* (ragweed)			5													
Chenopodium sp. (lamb's quarters)														1		
Galium cf. *aparine* (bedstraw)										5		2				
Geum canadense (white avens)												1	1			
Hypoxis hirsuta (stargrass)													1			
Poaceae (grass family)													2			
Polygonum sp. (trigonal) (knotweed)							1									
Portulaca oleracea (purslane)													1			
Prunus sp. (cherry size)			2					1								
Rumex sp. (dock)			2													
Vitis sp. (wild grape)			1						1			2				
Indeterminate						1	1			1	1	1	1			

[a]The count for wood charcoal represents the number of fragments, for seeds it is the seed number estimate (SNE) of carbonized seeds (see text).

rials all appear to indicate that the site was used mainly for hunting during the colder months of the year. Such an assertion, however, does not preclude other, less frequent uses of the site during warmer times of the year. Occasionally exploited native plant foods consisted of hickory nuts, walnuts, acorns, hazelnut, wild cherry, and wild grape. If not brought from a base settlement, these would have been exploited in the vicinity of the Big Eddy site anywhere from July-August (wild cherry and hazelnut) until about mid-November (hickory nuts and walnuts).

No evidence exists for any horticultural or agricultural activities at the Big Eddy site, nor was it found at Rodgers Shelter. Nevertheless, the absence of maize and certain other cultivated plants at these two sites should not be regarded as evidence that late-prehistoric peoples in this region were hunters and gatherers only, or nonhorticultural/nonagricultural. Despite the fact that relatively few sites in the western Ozarks have undergone systematic archaeobotanical studies, a sufficient amount of evidence has accumulated to indicate that squash, gourd, and native starchy and oily seeds were being cultivated at least 2,000–3,000 years ago in the Ozarks, and maize cultivation was widespread by at least A.D. 700–900 (Dunavan 1992; Fritz 1986; Lopinot 1995; Voigt 1982). During the fourteenth and fifteenth centuries, Neosho tradition groups living in the nearby Spring River valley to the south also were heavily dependent on maize agriculture (Lopinot and Fadler 1996).

LATE ARCHAIC WILLIAMS COMPONENT

The general contents of flotation samples derived from Late Archaic contexts at the site are presented in Tables 10.3–10.5. These consist of seven feature samples and two columnar series of seven samples each from the midden deposits in Block A. As described in Chapter 8, this midden is assigned to the middle Late Archaic Williams component. Five of the seven features are also related to the Williams component (Features 18, 20, 22, 30, and 31), whereas the other two (Features 17 and 19) represent possible tree burns dating to early Late Archaic times. Although data are presented in Table 10.3 for the possible tree burns, these are ignored in the subsequent descriptions and discussion.

Chipped stone is particularly common in two of the seven feature samples. These samples are from Features 20 and 22, both of which were defined within the midden deposit in Block A. Debitage measuring 1.0 mm or greater in size is also relatively abundant throughout the midden deposits. Figure 10.1 illustrates the estimated densities of such artifacts based on extrapolations from materials in the two flotation series. The variability between the two columns can be expected partly because the samples derive from a midden deposit where many types of refuse were discarded during the course of a season or year.

In contrast to the inorganic chipped stone, the quantities of flotation-recovered plant and animal remains ≥2.0 mm in size are relatively scant for all of the samples, especially for a true midden deposit. Much of the plant material is poorly preserved, and only small pieces of calcined bone occur in the flotation samples. The relative paucity of biological materials contrasts greatly with expectations for a midden deposit, which visually consisted of dark, organically enriched soils with abundant quantities of charred plant remains, particularly hickory nut shell, and moderately dense patches of calcined bone. A more gentle approach to flotation could result in the recovery of greater quantities of plant debris, and a different method should be employed if additional excavations of these deposits are undertaken in the future. However, it is also notable that the use of the same flotation procedures for the features on the stripped surface and for samples from numerous other sites has resulted in the recovery of relatively abundant quantities of plant and animal remains.

The overall poor condition and the scant amounts of recovered plant and animal materials can be attributed primarily to two factors: (1) postdepositional conditions that were not favorable for the long-term preservation of incompletely carbonized plant tissues and noncalcined skeletal parts, and (2) deterioration of biological materials due to exposure on the surface of the midden. Soil pH samples from immediately above and within the midden deposits yielded readings of 6.0–6.2, or medium to weakly acidic. Such conditions are not favorable for the preservation of faunal materials. It is also noteworthy that the recovered calcined bone and charred plant remains exhibit a moderate amount of erosional edge rounding and fragmentation. These alterations are likely the result of mechanical breakdown due to erosional movement and weathering (e.g., wetting-drying, freezing-thawing, etc.). This assertion further implies that

Table 10.3. Sorted and Counted Flotation Debris from Late Archaic Features.

Debris Class/Material Type	Feature 17 N	Feature 17 Weight (g)	Feature 18 N	Feature 18 Weight (g)	Feature 19 N	Feature 19 Weight (g)	Feature 20 N	Feature 20 Weight (g)	Feature 22 N	Feature 22 Weight (g)	Feature 30 N	Feature 30 Weight (g)	Feature 31 N	Feature 31 Weight (g)	Total N	Total Weight (g)
Fuel/construction																
Wood charcoal	42	1.81	28	0.19		P		P		P	6	0.06		P	76	2.06
Bark	7	0.05			1	0.01		P		P				P	8	0.06
Nut Remains																
Hickory nut shell							3	0.03	88	2.12		P	1	T	92	2.15
Walnut shell																
Juglandaceae nut shell		P	1	0.01		P	2	0.01	75	0.86					78	0.88
Acorn shell							1	T		P		P	2	0.01	3	0.01
Rhizome								P								P
Indeterminate													1	0.02	1	0.02
Total	49	1.86	29	0.20	1	0.01	6	0.04	163	2.98	6	0.06	4	0.03	258	5.18
Sample volume (liters)	9.0		9.0		9.0		18.0		9.0		9.0		2.5		65.5	
Debitage (n)																
≥ 2.0 mm					1		7		3						11	
1.0–2.0 mm	1		8		1		42		16				2		70	

Table 10.4. Sorted and Counted Flotation Debris from Block A, Column I.

Debris Class/ Material Type	210–215 cm N	210–215 cm Weight (g)	215–220 cm N	215–220 cm Weight (g)	220–225 cm N	220–225 cm Weight (g)	225–230 cm N	225–230 cm Weight (g)	230–235 cm N	230–235 cm Weight (g)	235–240 cm N	235–240 cm Weight (g)	240–245 cm N	240–245 cm Weight (g)	Total N	Total Weight (g)
Fuel/construction																
Wood charcoal	9	0.06	7	0.04	2	T	11	0.28	4	0.05	7	0.06	P		40	0.49
Bark									P		P		P		P	
Grass/herb stem											P				P	
Fungal tissue							P						P		P	
Nut remains																
Hickory nut shell	3	0.02	7	0.32	5	0.16	7	0.11	14	0.52	5	0.09	4	0.07	45	1.29
Juglandaceae nut shell	1	T	3	0.01	5	0.04	4	0.02	7	0.07	10	0.06	4	0.03	34	0.23
Acorn shell			P		1	T	P		P		P		P		1	T
Fruit flesh	P		2	0.01	P		P		P		P		P		2	0.01
Rhizome							P								P	
Siliceous mass									1	T					1	T
Indeterminate					2	0.01									2	0.01
Total	13	0.08	19	0.38	15	0.21	22	0.41	26	0.64	22	0.21	8	0.10	125	2.03
Sample volume (liters)	11.1		15.0		10.0		10.5		10.5		10.0		10.0		77.1	
Bone (n ≥ 2.0 mm)									1		3				4	
Debitage (n)																
≥ 2.0 mm	4		41		20		16		25		18		15		139	
1.0–2.0 mm	7		92		47		38		52		43		27		306	

Table 10.5. Sorted and Counted Flotation Debris from Block A, Column II.

	210–215 cm		215–220 cm		220–225 cm		225–230 cm		230–235 cm		235–240 cm		240–245 cm		Total	
Debris Class/ Material Type	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)
Fuel/construction																
Wood charcoal	1	T	3	0.03	4	0.03	8	0.10	4	0.02	6	0.03	3	0.02	29	0.23
Bark	P				P		1	T			1	0.01	P		2	0.01
Grass/herb stem					P										P	
Fungal tissue									P		P				P	
Nut remains																
Hickory nut shell	1	0.01	1	T	7	0.15	15	0.18	11	0.12	13	0.21	13	0.18	61	0.85
Walnut shell					1	0.01									1	0.01
Juglandaceae nut shell	P		P		7	0.06	6	0.03	2	0.01	6	0.03	15	0.08	36	0.21
Acorn shell	P		P		P		P		1	T	P		P(?)		1	T
Fruit flesh	P		P		P		1	T	P		P		1	T	2	T
Total	2	0.01	4	0.03	19	0.25	31	0.31	18	0.15	26	0.28	32	0.28	132	1.31
Sample volume (liters)	13.5		13.0		14.0		10.0		10.0		10.5		10.0		81.0	
Bone (n ≥ 2.0 mm)							1								1	
Debitage (n)																
≥ 2.0 mm	4		6		18		16		12		6		2		64	
1.0–2.0 mm	19		20		30		50		33		12		11		175	

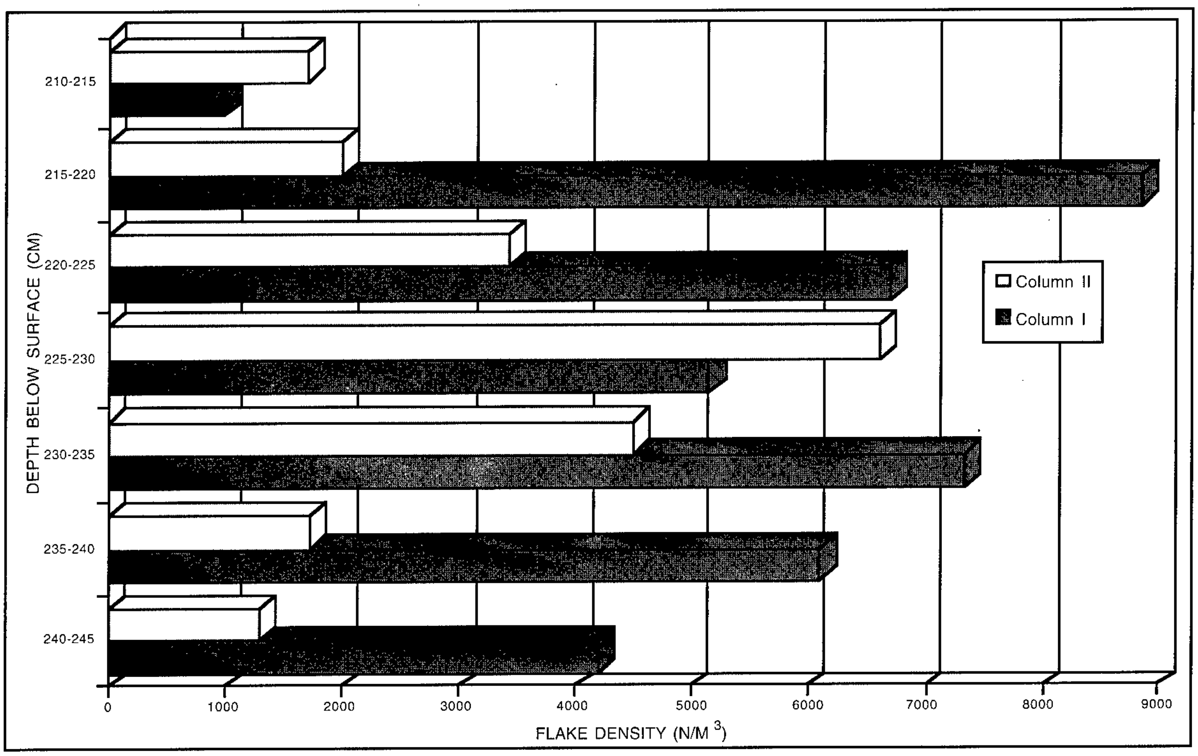


Figure 10.1. Chipped-stone debris densities by depth for Block A midden.

the midden deposits accreted at a sufficiently slow pace to allow for such destruction. Central, unexcavated portions of the midden and, if (still) present, more rapidly in-filled pit features should exhibit better preservation of faunal and botanical remains.

Despite the overall poor recovery of biological remains, the archaeobotanical record for the midden deposit and associated features in Block A provides some good evidence for human-plant relations in this region at ca. 4020–4040 B.P. The sealed nature and deep burial of debris in the Williams component midden preclude mixture of debris from other components at the site. In this regard, it is noted that samples from the midden deposits and associated features entirely lacked uncarbonized seeds, rootlets, and other plant tissues indicative of active biological activities and contamination. Thus, the results obtained from the analysis of this midden represent an ideal, "pure" set of data.

Wood charcoal occurs in all of the samples, and bark is present in eight of the 14 samples. Other fuel/construction materials consist of a grass-stem fragment in a Column I sample, a small herb-stem fragment in a Column II sample, and fungal materials in four samples from the middle and lower portions of the midden deposit. The wood is dominated by oak and hickory (Table 10.6). Combined, they comprise 70% of the identified specimens. Five other wood taxa are represented. Wood charcoal identified as elm/hackberry occurs in three samples, whereas wood fragments of persimmon, ash, and honey locust/Kentucky coffeetree were found in two samples each. Walnut/butternut wood is represented in a single sample. The spectrum of represented wood is consistent with that found in the Sac River floodplain by General Land Office surveyors in the early nineteenth century (see Chapter 2).

Sorted fractions of the midden samples are dominated by nut shell consisting almost exclusively of hickory/pecan nut shell. Nut shell accounts for 179 specimens, or 69.6% of the total count (n=257), and 2.59 g, or 77.5% of the total weight (3.34 g) for sorted materials in the 2.0-mm fractions. Hickory/pecan nut shell fragments occur in all 14 samples, whereas acorn shell is represented

Table 10.6. Identified Wood and Seeds from Block A, Columns I and II.

	Column I		Column II	
Identified Taxon	N[a]	% of Total Identified	N[a]	% of Total Identified
Wood charcoal				
Quercus spp. (white oak group)	3	12.5	2	10.5
Quercus spp. (red oak group)	3	12.5		
Quercus spp. (indeterminate)	4	16.7	3	15.8
Carya spp. (true hickory)	9	37.5	6	31.6
Diospyros virginiana (persimmon)	2	8.3	1	5.3
Fraxinus spp. (ash)	2	8.3	1	5.3
Gleditsia/Gymnocladus spp.	1	4.2	1	5.3
Juglans spp. (walnut/butternut)			1	5.3
Ulmaceae (elm/hackberry family)			4	21.1
Ring porous	10		6	
Diffuse porous			1	
Indeterminate	6		3	
Total	40	100.0	29	100.2
Seeds				
Chenopodium berlandieri (chenopod)	33	76.7	44	86.3
Diospyros virginiana (persimmon)	1	2.3		
Galium sp. (bedstraw)	1	2.3		
Panicum sp. (panic grass)			1	2.0
Phytolacca americana (pokeweed)	2	4.7	1	2.0
Polygonum spp. (biconvex knotweed)	1	2.3	2	3.9
Rhus sp. (sumac)	1	2.3		
Vitis spp. (wild grape)	4	9.3	3	5.9
Indeterminate	9		6	
Total	52	99.9	57	100.1

[a]The count for wood charcoal represents the number of fragments, for seeds it is the seed number estimate (SNE) of carbonized seeds (see text).

in 13, or all but one, of the samples. Only one piece of black walnut shell (*Juglans nigra*) occurs in a sample from Column II.

Of the 106 specimens identified to *Carya* spp., 89 comprise fragments of relatively thick-shelled hickory nuts such as shagbark hickory (*C. ovata*), mockernut hickory (*C. tomentosa*), and black hickory (*C. texana*). The remaining 17 fragments, represented in six different samples from both columns, are from relatively thin-shelled nuts, and several are from pecans (*C. illinoensis*). Although not documented as being present in Cedar County by Steyermark (1963:511) and Settergren and McDermott (1972:17), pecan is shown by these authors to occur in nearby St. Clair County, and pecan was documented by the GLO surveyors in the lower Sac River valley in 1835. The intensive exploitation of hickory/pecan nuts is a pattern mirrored at other Late Archaic sites in the Midwest (e.g., Asch et al. 1972; Lopinot 1984; Yarnell and Black 1985).

The nearly ubiquitous occurrence of acorn shell is a likely indication that oak acorns were quite important to the middle Late Archaic occupants of the Big Eddy site. The limited number of fragments in the 2.0-mm fractions and their paucity in smaller fractions is probably the consequence of the overall poor preservation characterizing the midden deposit. Most of the acorn shell fragments are in very poor condition and were quite difficult to recognize at low magnification. Given that the thinner, more

fragile acorn shell is considerably less apt to withstand carbonization and postdepositional mechanical breakdown than the thicker-shelled hickory nuts (Lopinot 1984), it seems reasonable to argue that acorns constituted an important supplementary, if not first-line, resource during middle Late Archaic times.

Fruit flesh also is represented in all 14 samples. These generally consist of small, amorphous fragments, although at least a few larger fragments are present. At least some of the fruit flesh fragments are identifiable as being derived from hickory/pecan nut meats. The ubiquitous occurrence of such materials indicates either: (1) that the nuts were being processed and nutmeats sometimes were lost or abandoned and subsequently incorporated into the midden deposit, or (2) that nutmeats or unshelled nuts (later broken) were frequently discarded due to rancidity or insect infestation.

Eight different seed taxa have been identified (Table 10.6), and most of these represent lost or abandoned food remains. The most intriguing aspect of the seed assemblage for the Williams component is the relative abundance of chenopod seeds. They are ubiquitous, occurring in all 14 samples. The total SNE of 77 is based on the occurrence of two perisperms and 350 testa or seed-coat fragments. Both perisperms measure 1.2 mm in diameter, whereas 25 measurable seed-coat fragments have a diameter range of 1.1–1.6 mm, with a mean of 1.33 mm. The seed-coat fragments are typically pitted or have textured surfaces. The absence of complete specimens makes it impossible to evaluate margin shape with any certainty; nevertheless, the sufficiently large testa fragments indicate that the margins are mildly acute or slightly rounded. Such shapes are typical of the wild forms of *Chenopodium* and not of known domesticated varieties (see Smith 1992:112). This, however, should not be regarded as evidence that the middle Late Archaic group(s) at the Big Eddy site were collecting from wild chenopod stands.

The ubiquitous occurrence of chenopod seeds indicates that these fruits constituted a very important resource, perhaps even one that was cultivated or at least propagated through intentional disturbance of the landscape. We know that domesticated chenopod was present in at least some areas of eastern North America, including the Ozarks, by at least 3,000 years ago (Cowan 1985; Fritz 1994, 1997; Gremillion 1997), so it is not a great stretch to expect chenopod cultivation in such areas about 1,000 years earlier. Future studies of seed-coat thicknesses from a larger population of chenopod achenes could help resolve the question regarding the wild vs. domesticated status of this middle Late Archaic seed population.

Other seed taxa that probably constituted economically important resources minimally included wild grape, knotweed, and perhaps pokeweed. Seed fragments of these plants are represented in seven, three, and three samples, respectively. Minimally, wild grape fruits apparently were commonly exploited by the middle Late Archaic groups in the late summer and early fall. A whole knotweed achene, measuring 2.8 mm in length and 2.1 mm in width, is represented in a Column II sample (225–230 cm bs). As for the other knotweed achene fragments, they are from a species that produces smooth-coated, biconvex achenes. Persimmon, bedstraw, panic grass, and sumac are represented by singular occurrences of seed fragments. Of these, the fruits of at least persimmon and sumac were commonly exploited by Native American groups prior to modern times (Yanovsky 1936:40–41, 52).

In summary, the middle Late Archaic occupants of the Big Eddy site appear to have been engaged in a variety of activities. Hickory nuts, pecans, and acorns were intensively exploited, along with at least the fruits of wild grape. Chenopod also was an extremely important resource that may have been cultivated. Determining whether it represents an incipient or a true domesticate, however, must await more detailed research on a larger population of better-preserved achenes. Given that gourd and squash have been recovered from essentially contemporaneous deposits (dating to about 3,900–4,000) at Phillips Spring in the neighboring Pomme de Terre valley (Kay et al. 1980), the cultivation of chenopod at this time in the extreme northwestern Ozarks seems quite possible. Despite the fact that bone preservation is relatively poor and our knowledge of faunal procurement is extremely limited, the abundance of nut and seed residues in a midden that developed within an accreting terrace suggests multiseasonal, if not year-round, site usage. It is predicted that structures or other living surfaces, along with hearths and other types of features, probably occur somewhere in the vicinity of this midden. Quite possibly, the preservation of plant and hopefully animal materials is better within such features or another unsampled portion of the midden.

EARLY ARCHAIC AND PALEOINDIAN COMPONENTS

Forty-eight flotation samples obtained from Early Archaic and Paleoindian contexts in Blocks B-D were analyzed. These consist of 16 samples from 15 features, as well as two columns of 16 samples each. The columns derive from the east wall of Block B and the south wall of Block C. An additional column was obtained from the south wall of Block C, but a rodent/root disturbance was observed during the removal of the samples; for that reason, this column has not been analyzed. Besides the flotation samples, all bits of charcoal were examined before submission for AMS dating (see Table 7.1).

The preservation of plant materials is poor, prompting the sorting of all charred plant remains larger than 0.5 mm. Counts and weights were obtained for all charred plant remains captured by the 1.0-mm sieve (Tables 10.7–10.9). Those in the 0.5-mm fraction were merely noted as present (P). Future archaeobotanical investigations of these deposits should focus on at least the counting of plant remains that are larger than 0.5 mm. In comparison to charred plant remains, the quantities of chipped-stone debris are great, and much time was expended sorting these materials in an effort to shed some light on the integrity of the Paleoindian deposits in particular.

Considerable concern can be anticipated regarding the integrity of the Early Archaic and Paleoindian deposits at the Big Eddy site. This is due in part to their relatively great age and therefore the lengthy period of time they were subject to disturbance by wind, water, bacteria and other microorganisms, rodents, and so forth. It is important to collect and examine a variety of data relating to processes of postdepositional disturbance. This will allow discrimination between data that provide undisturbed, culturally meaningful evidence of past human behavior and data that primarily reflect noncultural factors.

Elsewhere in this report, it has been argued that the Big Eddy site has very good integrity for a variety of reasons: (1) the intact nature of the lithic features in the Late Paleoindian deposits, (2) the macroscopic absence of abrasional scarring on flake surfaces and of other evidence for extensive fluvial movement of debris, (3) the depositional environments of the artifact-bearing horizons, (4) the general concurrence of the suites of radiocarbon dates, and (5) the results of the refit studies that indicate relatively minimal horizontal and vertical movement of materials. Still, the integrity of the Paleoindian deposits, particularly that reflected by micromaterials, can be questioned somewhat. Some radiocarbon dates from the deepest excavated levels of the site are inconsistent with the majority of the dates from various horizons. Thus, some carbonized plant remains have indeed moved horizontally and vertically as a result of a variety of postdepositional processes. During excavation, a few rodent burrows also were observed, one of which extended through the gravel bed encountered at 390–410 cm bs. Given the intensity of use of the site during Paleoindian times, particularly as reflected in the deposits at 295–310 cm bs, one can also expect that trampling had some impact on material distribution, particularly on the more mobile, smaller materials.

One of the major aspects of the flotation analysis for the earliest deposits at the Big Eddy site involved the sorting of chipped-stone debris in two size fractions (≥2.0 mm and 2.0–1.0 mm) for each sample. Although left unsorted, it is noted that chipped-stone materials smaller than 1.0 mm are extremely abundant, with some samples estimated as having as many as a thousand to even several thousand flakes smaller than 1.0 mm.

The two flotation columns provide useful information in evaluating the movements of different-sized materials. Samples in these two columns were removed at 5-cm intervals, extending from the early Early Archaic levels (270–285 cm bs) into the Early/Middle Paleoindian levels (330–350 cm bs). The basic estimates of density (n/m^3) are shown in Figure 10.2. Note that these density estimates are based only on materials in the two sorted fractions. Furthermore, the densities have been computed from bucket-measured soil volumes with a range of 10.0–14.0 liters. These are about double the volume of the in situ samples, which measured 50-x-25-x-5 cm (6.25 liters). Using the in situ volume, the density of chipped-stone artifacts in the richest Late Paleoindian deposits (295–310 cm) in Block C ranged from 58,880 n/m^3 to 81,120 n/m^3.

Examination of Figure 10.2 suggests that there is considerable variability within the deposits, both horizontally and vertically. The density estimates for the Block C column have been effected, however, by the presence of Feature 28, the largest of the Late Paleoindian knapping concentrations ex-

Table 10.7. Sorted and Counted Flotation Debris from Late Paleoindian Features.

	Feature 23		Feature 24		Feature 25		Feature 26		Feature 27		Feature 28		Feature 28		Feature 29	
Debris Class/Material Type	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)
Fuel/construction																
Wood charcoal		P		P		P				P		P		P		P
Bark										P						
Twig	2	T														
Grass/herb stem												P				
Rhizome																
Indeterminate										P						P
Total	2	T		P		P				P		P		P		P
Sample volume (liters)		5.0		9.0		9.0		9.0		4.5		9.0		9.0		9.0
Debitage (n)																
≥ 2.0 mm		117		90		6		40		4		605		243		217
1.0–2.0 mm		224		163		23		142		115		992		417		419

	Feature 32		Feature 33		Feature 36		Feature 37		Feature 40		Feature 41		Feature 42		Total	
Debris Class/Material Type	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)
Fuel/construction																
Wood charcoal						P	1	T	1	T	1	T	1	T	4	T
Bark																P
Twig															2	T
Grass/herb stem																P
Rhizome							1	T					1	T	2	T
Indeterminate				P		P	1	T							1	T
Total				P		P	3	T	1	T	1	T	2	T	9	T
Sample volume (liters)		4.0		8.0		9.0		9.0		8.0		7.0		9.0		117.5
Debitage (n)																
≥ 2.0 mm		217		482		109		24		28		6		108		2,296
1.0–2.0 mm		327		827		202		76		163		50		370		4,510

Table 10.8. Sorted and Counted Flotation Debris from Block B, Column III.

	270–275 cm		275–280 cm		280–285 cm		285–290 cm		239–295 cm		295–300 cm		300–305 cm		305–310 cm	
Debris Class/Material Type	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)
Fuel/construction																
Wood charcoal		P		P			1	T				P	1	T		P
Bark				P												
Indeterminate				P		P		P		P				P		P
Total		P		P		P	1	T		P		P	1	T		P
Sample volume (liters)	10.0		10.0		10.0		11.0		11.0		10.0		11.0		10.2	
Debitage (n)																
≥ 2.0 mm	3		1		3		1		1		4		8		9	
1.0–2.0 mm	15		18		17		11		20		19		20		20	

	310–315 cm		315–320 cm		320–325 cm		325–330 cm		330–335 cm		335–340 cm		340–345 cm		345–350 cm	
Debris Class/Material Type	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)	N	Weight (g)
Fuel/construction																
Wood charcoal		P						P						P		P
Bark																P
Indeterminate				P		P				P		P		P		P
Total		P		P		P		P		P		P		P		P
Sample volume (liters)	13.0		10.5		10.0		10.0		11.0		11.0		10.0		10.0	
Debitage (n)																
≥ 2.0 mm	5		3		2		1		1							
1.0–2.0 mm	25		20		11		12		11		21		9		13	

Table 10.9. Sorted and Counted Flotation Debris from Block C, Column I.

Debris Class/Material Type	270–275 cm N	270–275 cm Weight (g)	275–280 cm N	275–280 cm Weight (g)	280–285 cm N	280–285 cm Weight (g)	285–290 cm N	285–290 cm Weight (g)	290–295 cm N	290–295 cm Weight (g)	295–300 cm N	295–300 cm Weight (g)	300–305 cm N	300–305 cm Weight (g)	305–310 cm N	305–310 cm Weight (g)
Fuel/construction																
Wood charcoal	6	0.02	2	T	1	T		P	2	T	3	T	5	0.01		P
Fungal mass						P										
Indeterminate	13	0.04	14	0.03	11	0.02	5	0.01	2	T		P	2	T		
Total	19	0.06	16	0.03	12	0.02	5	0.01	4	T	3	T	7	0.01		P
Sample volume (liters)	13.0		13.0		13.5		14.0		13.0		13.5		13.0		13.0	
Debitage (n)																
≥ 2.0 mm	28		18		18		33		55		127		164		87	
1.0–2.0 mm	35		69		88		96		131		257		337		281	

Debris Class/Material Type	310–315 cm N	310–315 cm Weight (g)	315–320 cm N	315–320 cm Weight (g)	320–325 cm N	320–325 cm Weight (g)	325–330 cm N	325–330 cm Weight (g)	330–335 cm N	330–335 cm Weight (g)	335–340 cm N	335–340 cm Weight (g)	340–345 cm N	340–345 cm Weight (g)	345–350 cm N	345–350 cm Weight (g)
Fuel/construction																
Wood charcoal	1	T		P		P								P		
Fungal mass																
Indeterminate				P												
Total	1	T		P		P								P		
Sample volume (liters)	13.0		13.0		13.5		13.5		13.0		13.5		13.5		13.0	
Debitage (n)																
≥ 2.0 mm	38		26		3		1				2		1			
1.0–2.0 mm	154		78		29		14		2		10		15		2	

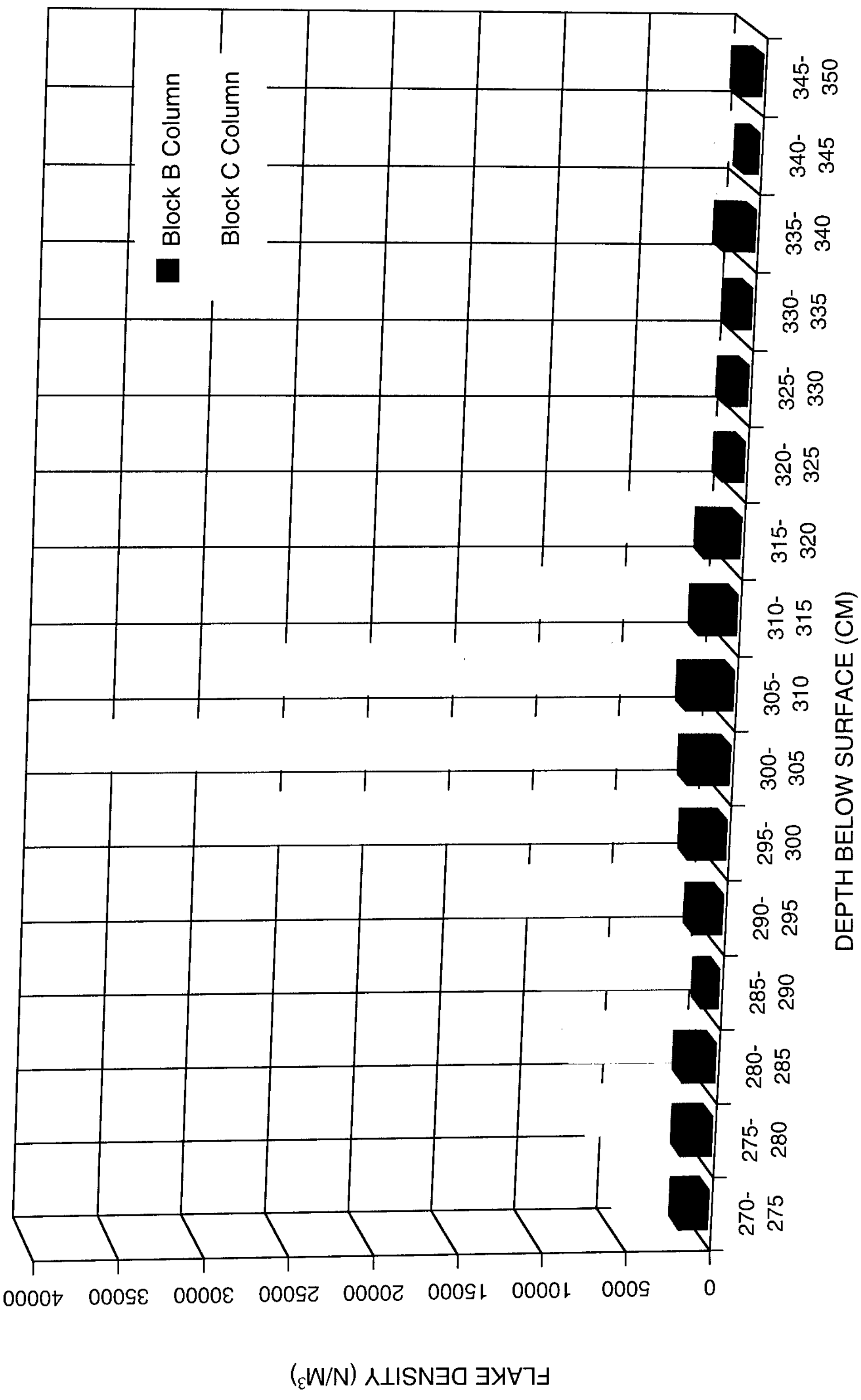


Figure 10.2. Debitage density vs. depth in Blocks B and C.

posed in Blocks B-D. The Block C column was located along the western edge of Feature 28, and it can be assumed that the very high material densities are due to the inclusion of knapping debris from along the edge of this large feature. Block B is probably more representative of the generalized cultural deposits at the Big Eddy site.

The Block B column shows three peaks that appear to coincide relatively nicely with the Early Archaic, Late Paleoindian, and Early/Middle Paleoindian horizons. These peaks occur at 280–285 cm bs, 305–310 cm bs, and 335–340 cm bs. Although the upper portion of the Column C flotation series is clouded by debris from Feature 28, the Early Paleoindian peak is even more clearly evident in the two levels at 335–345 cm bs. Clearly, more flotation columns and fine screening of unit levels are needed, but these scant flotation data do appear to connote the general separation and good integrity of the Early Archaic, Late Paleoindian, and Early Paleoindian deposits.

Closer examination of the different size fractions (Figures 10.3 and 10.4) do show general concordance of the relative quantities of chipped stone in the two size fractions for both columns, indicating little movement of smaller artifacts relative to larger ones. Any movement that has occurred seems to have been on the order of no more than about 5–10 cm. This is reflected perhaps by the fact that the fluctuations in quantities for the smaller 1.0–2.0-mm fractions in Block B are generally about 5 cm deeper than for the larger 2.0-mm fractions. For example, compare the levels at 305–310 cm bs and 310–315 cm bs for the Block B column. A greater number of columns would be needed to increase the confidence of the assertion about the relatively good integrity. However, it is hard to deny the many forms of evidence that indicate little movement of artifacts following deposition during and prior to Early Archaic times.

As mentioned above, plant remains are generally meager in number and in relatively poor condition. Singular pieces of wood charcoal were present in the 1.0-mm fractions of only two level samples from the Block B column, although small bits of charred plant materials did occur in all of the samples, ranging from one to 12 specimens per sample. Peak numbers of plant remains occur in level samples from 275–280 cm bs (12 specimens) and 345–350 cm bs, or the deepest level in Column III. In comparison, plant remains were considerably more abundant in upper samples from the Block C column, but charred materials were lacking in four of the six deepest samples within the Early Paleoindian deposits. Five small slivers of wood charcoal occur in the 0.5-mm fraction of the sample from 320–325 cm bs, and only two wood charcoal fragments occur in the 0.5-mm fraction of the sample from 340–345 cm bs.

None of the wood charcoal fragments in the samples exhibit a complete annual ring. Many of the specimens are distorted or exhibit some form of tissue degradation, making identification impossible based on intercellular structure using a standard binocular microscope with a maximum magnification of 40X. Many specimens, however, could be identified to at least the generic level by analyzing minute anatomy (e.g., vessel/tracheid diameter, perforation plates, intervessel pits, forms of ray cells, etc.) using a high-powered stereomicroscope or an electron microscope.

The most common plant remains other than wood charcoal are amorphous carbon materials that apparently have been altered pedogenically. Occasionally, portions of these objects retain woody elements, but they do not appear to represent carbonized gum or resin. Some of these objects are shiny and "molten" in appearance, resembling melted blackened silica and bits of black cinders. The chemical constituents of these materials should be examined (e.g., using an electron microprobe) to determine their origin. Besides these materials, it is noted that two possible bone fragments and an indeterminate tooth fragment occur in samples from Features 28 and 33, respectively.

Fragments of three seed taxa that could represent food residues occur in three level samples from the Block B column, two level samples from the Block C column, and a feature sample. For Column III in Block B, singular carbonized testa halves of chenopod (*Chenopodium* spp.) achenes are present in level samples from 290–295 cm bs, 295–300 cm bs, and 310–315 cm bs. For Column I in Block C, singular carbonized wild grape (*Vitis* sp.) pip fragments are present in level samples from 315–320 cm bs and 335–340 cm bs. A tentatively identified small piece of very eroded acorn shell also is present in the sample from 315–320 cm bs. Finally, two testa fragments from two different chenopod species occur in the flotation sample from Feature 41 in Block D. Two of the five chenopod achenes measuring 1.1 mm and 1.0 mm in diameter are from a taxon having thick, relatively smooth seed coats. The other three achenes are from a taxon that pro-

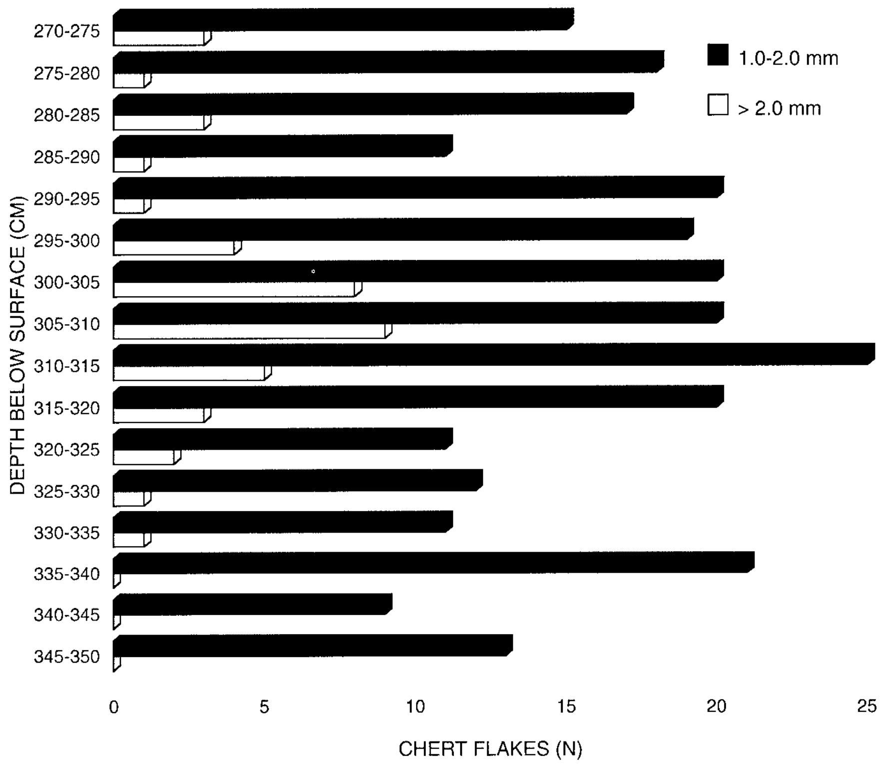


Figure 10.3. Number of chert flakes by depth, Block B, Flotation Column III.

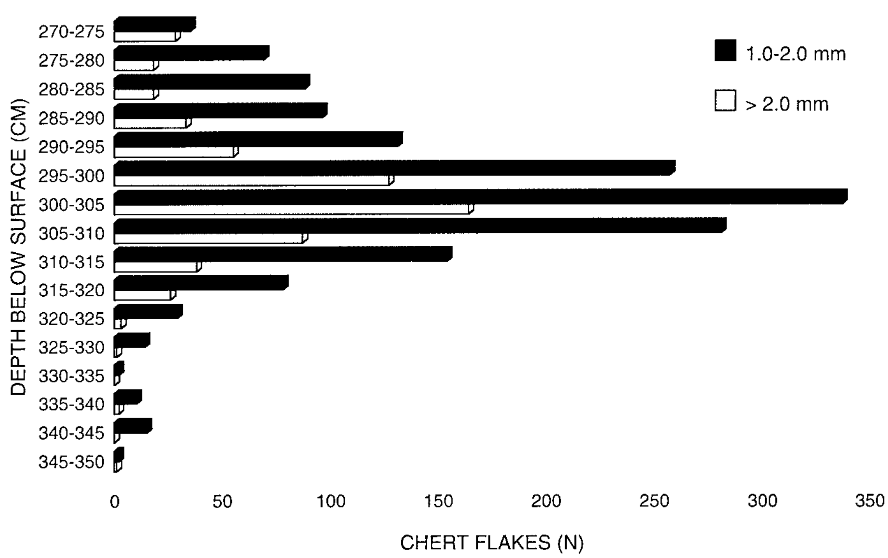


Figure 10.4. Number of chert flakes, Block C, Flotation Column I.

duces slightly larger achenes (1.1 mm, 1.2 mm, and 1.2+ mm in diameter) having thinner seed coats with pronounced reticulations.

The data for subsistence activities during the earliest occupations of the Big Eddy site are quite limited. Even given the poor preservation of biological materials, however, it seems apparent that the Late Paleoindian and Early/Middle Paleoindian occupants were doing more at the Big Eddy site than simply manufacturing bifaces. Assuming that their presence is not due to contamination, such groups were minimally procuring wild grapes, chenopod, and perhaps acorns.

Although scant, the archaeobotanical evidence from the Big Eddy site for the Paleoindian period represents a substantial addition to a very small handful of extant data. The only other sites in eastern North America known to the author to have produced possible plant-food remains from Early/Middle Paleoindian contexts are the Shawnee Minisink site along the upper Delaware River in Pennsylvania and the Hedden site, located on the Kennebunk Plains in southwestern Maine. For the Paleoindian deposits at the Shawnee Minisink site, Dent and Kauffman (1985:Table 5.2) document seeds of at least 10 different annual and perennial plants, including chenopod and wild grape. Other represented seed remains represent several fleshy fruits in addition to wild grape. These consist of blackberry, hawthorn, and hackberry. For the Hedden site, Sidell (1995) has identified seed remains of raspberry/blackberry, bunch berry, bristly sasaparilla, and grape. The few dates obtained from both sites suggest that they were utilized during the Middle Paleoindian period, or between ca. 11,000 and 10,500 B.P.

The evidence from these two sites points to fleshy fruits as being important resources to Paleoindian populations. The presence of wild grape seed fragments in the upper Late Paleoindian deposits and in the lower Early/Middle Paleoindian deposits provides some support, albeit limited, for this contention. Nevertheless, the presence of some of these seeds might not be expected unless they were collected, processed, and consumed in large quantities, given the fact that most fleshy fruits are adapted for fecal dispersal. Consequently, one might not expect to find such seeds commonly in archaeological deposits, particularly those derived from everyday work- and leisure-related activities.

RECOMMENDATIONS

There is little additional information that can be learned about the Mississippian/Woodland components at the site. However, there is much that could be learned about various Archaic components, particularly the Late Archaic and Early Archaic components. The sealed nature and deep burial of debris resulting from a relatively short-lived occupation makes the middle Late Archaic Williams component an exciting discovery worthy of more intensive and extensive investigation. The presence of a large midden deposit containing abundant quantities of nut shell and possibly cultivated chenopod could indicate that the Big Eddy site was the locus for multiseasonal if not year-round occupation.

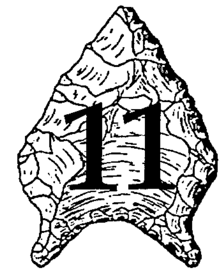
It is evident that the record for the earliest deposits at the site is limited owing to relatively poor preservation of organic materials, even carbonized plant remains. The relatively poor preservation of plant remains in the Paleoindian deposits is nothing new for sites of this age. Because of this, alternative processing techniques and more intensive types of analyses (e.g., electron microscopy and microprobing) will be necessary. It is also strongly recommended that AMS assays be obtained on samples of any possible carbonized food remains from these deposits.

During removal of flotation samples from Block B, it was observed that plant materials were common in the Early Archaic deposits above the 3Ab. This is not reflected in the data presented in Table 10.8. Plant materials, therefore, may have been destroyed during sample processing. In the future, the primary objectives should be: (1) to collect substantially larger and more numerous flotation samples and (2) to attempt to devise a system that maximizes recovery with the least amount of fragmentation and processing losses. Sample sizes should be increased at least three-fold to four-fold. If future excavations are undertaken in 0.5-x-0.5-m subunits, whole subunits of this size perhaps should be collected and processed.

The collection of flotation samples in association with Paleoindian lithic features is a matter of considerable importance, particularly if we are to gain a better understanding of the activities that resulted in their formation. Some of the flotation samples from lithic features in the Paleoindian deposits

were obtained from immediately below the chipped-stone concentrations or at the base of those features. This probably accounts for the fact that some samples contained few pieces of chipped stone in the 2.0-mm fraction but relatively abundant quantities of the smaller, more mobile pieces. Lithic features identified in the future should be pedestalled for mapping and photography, but the sediments removed in the process of highlighting the lithic debris within those features should be kept along with those composing the remaining pedestalled feature. All of the feature matrix should undergo flotation.

CONCLUSIONS AND RECOMMENDATIONS



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The CAR investigations of Big Eddy were intended to result in the mitigation of impacts to the site, but unexpected findings have relegated the level of investigations to that of an extensive testing program. With the exception of the remains of a partly exposed possible late-prehistoric structure (Feature 2), the plow-zone and upper sub-plow-zone deposits have been adequately mitigated. A relatively large proportion of the plow zone was removed from the central part of the site within the COE easement. All encountered features, many of which proved to be burned tree roots, were excavated. Numerous Woodland and/or Mississippian projectile points, fragments of a single ceramic vessel, and some plant-procurement data were recovered, but the information about these periods was considerably more meager than anticipated.

The Archaic and previously unknown Paleoindian components at the Big Eddy site proved to be considerably more complex and extensive than had been anticipated based on earlier testing. The buried and stratified Archaic and Paleoindian deposits have not been mitigated in any real sense. In addition, a case has also been made for the potential to define one or more Woodland and terminal Late Archaic components in upper portions of the thick part of the late Rodgers Shelter submember. Thus, the site still contains a massive amount of potential information, and one should consider the sub-plow-zone deposits as having only been tested (and for pre-Clovis deposits, inadequately so). Furthermore, the significance of the different buried cultural deposits at the site, which were essentially unknown until the completion of the 1997 field investigations, rapidly moved from the local level to the regional and national levels. If unimpeachable evidence can be found for pre-Clovis cultural activities, then the site's significance would move to the international level.

Pre-Clovis-age deposits are present at the site, but they were barely sampled. At present, we are still uncertain beyond a reasonable doubt that these deposits contain undisturbed residues of past human activities. However, if cultural materials are eventually found in these deeply buried deposits, the Big Eddy site would provide perhaps the best well-stratified evidence for pre-Clovis cultural activities in North America. Given the abundance of evidence for use of the site throughout prehistory, and particularly during Paleoindian times, the Big Eddy site is an extremely good candidate for finding evidence of pre-Clovis cultural activity. Datable and relatively thick deposits of this age are present at the site, and at least a small number of artifacts were recovered from potential pre-Clovis contexts in 1997. In addition, preliminary assessment of the geomorphic context suggests that even thicker deposits of pre-Clovis age are likely present immediately east of Blocks B-D.

The failure to adequately mitigate the entire Big Eddy site from top to bottom is due partly to the dearth of previously collected data regarding the content, dating, internal geomorphic structure, and extent of its more deeply buried cultural components. In other words, the inability to adequately mitigate the site can be attributed partly to the prior failure to adequately test the site. During the development of the data recovery plan for this project, we knew that our proposed field excavations were upside down—i.e., the extent of our excavations should have increased with depth, rather than decreased. However, this could not be avoided given OSHA requirements for stepping the excavations. Confronted with the decision to do something or to

do nothing, the USACOE, Burns and McDonnell, Inc., and CAR chose to do something. Our findings and this report attest to the correctness of that decision.

SYNOPSIS OF FINDINGS

Archaeological and geoarchaeological work at the Big Eddy site established the presence of multiple Paleoindian components in deep, well-stratified, and datable alluvial contexts. The site also contains a series of Mississippian, Woodland, and Archaic components. The 1997 excavations focused on mitigation of late-prehistoric deposits near the surface of the site and on examination of earlier, buried prehistoric cultural deposits in a late Pleistocene–Holocene alluvial member. This moderately weathered alluvial unit, exposed in a high cutbank, correlates with the Rodgers Shelter Formation defined in the neighboring Pomme de Terre River valley (Brakenridge 1981; Haynes 1976, 1985). Due to considerations of lithostratigraphic rank, it is more appropriate to refer to this unit as the Rodgers Shelter member (see Chapter 7). In the lower Sac River valley, the Rodgers Shelter member is composed of at least three distinct alluvial fills, tentatively identified as the early, middle, and late submembers. Near the center of the Big Eddy site, all three submembers occur in a single stacked profile that dates from the late Pleistocene through the late Holocene.

Late Archaic, Woodland, and Mississippian artifacts and deposits were found in the late Rodgers Shelter submember. The excavations showed that the late submember is extremely thick and well stratified in the western part of the Big Eddy site and that it is thin in the central part of the site. In the thick late submember, late-prehistoric features, a rich middle Late Archaic midden deposit, and several diagnostic artifacts were found. Artifacts are distributed throughout at least the upper 2.6 m of the thick late submember and may occur much lower in it. Thus, the late submember in this part of the site offers significant potential for delineating individual cultural components, thereby contributing greatly to our understanding of regional chronology and changing cultural lifeways during the middle to late Holocene.

A very small portion of an approximately 30-cm-thick midden deposit was found buried within the thick late Rodgers Shelter submember. This deposit is potentially quite extensive. It contains abundant plant and animal remains (though mostly calcined), as well as numerous diagnostic Williams Corner Notched projectile points, debitage, and other lithic debris (e.g., hematite and ground-stone tools). Although none of the recovered faunal remains could be identified to the generic level, the midden does contain possible cultivated, if not domesticated, plant remains, in addition to abundant quantities of hickory nut shell. The relatively large quantities of carbonized nut shell could reflect the harvest of surpluses needed for overwintering. The presence of such a midden also implies that house floors and other features perhaps occur somewhere in the vicinity.

The middle submember of the Rodgers Shelter member was the least investigated alluvial unit at the site. Late Archaic materials occur in a palimpsest in the 2Ab, or the upper part of the middle submember; however, deposits below the 2Ab have considerable potential for containing discrete components dating to the Middle and Early Archaic periods. Middle Archaic activities at the site appear to have been quite limited, at least within those parts of the site examined. The thickest part of the middle submember apparently dates to the Early Archaic period, when sediments were rapidly aggrading. Although only two Graham Cave Side Notched points were found in situ, a wide array of Early Archaic points (Rice Lobed, Cache River Side Notched, Hidden Valley Stemmed, Searcy Lanceolate, and Jakie Stemmed) have been recovered out of context along the cutbank. As such, the potential documentation of multiple Early Archaic cultural components in this thick early to middle Holocene deposit is very good.

The oldest alluvial fill, the early Rodgers Shelter submember, is about 2.2 m thick in Blocks B-D and contains stratified Paleoindian deposits within approximately the upper half. In the area of Blocks B-D, there is a well-expressed buried soil, designated as Buried Soil 1, that modifies this submember with an A–Bt–BC profile. A relatively discrete A horizon (3Ab) lies at a depth of about 285–320 cm bs. The relatively dark appearance of this horizon may in part be a consequence of enrichment as a result of intensive Late Paleoindian activities. Eighteen sediment cores pulled from two transects across the site traced Buried Soil 1 and indicated that the darkest portion of the 3Ab horizon occurs in the vicinity of Blocks B-C, between Blocks B-C and Block D, to the north of Block D about 20 m, and to the east of these blocks about 60 m. Diagnos-

tic Paleoindian artifacts (e.g., Gainey, Dalton, and San Patrice) and radiocarbon ages from the early Rodgers Shelter submember indicate that this alluvium was deposited at the end of the Pleistocene, between approximately 13,000 and 10,000 years ago. One point transitional between Dalton and Graham Cave was found just above the top of Buried Soil 1 in the basal increments of the overlying middle Rodgers Shelter submember.

Late Paleoindian artifacts are confined to the top of the early submember, which is modified by the 3Ab horizon of Buried Soil 1. At least two Late Paleoindian components have been identified: San Patrice and Dalton. A third component, tentatively designated as Wilson, also has been suggested. Dalton artifacts occur throughout the 3Ab horizon, whereas San Patrice artifacts appear to be restricted to the upper half. The presence of San Patrice and Wilson at the Big Eddy site on the northern fringe of their ranges may indicate periodic forays by groups from the south and southwest into the Sac River valley. Charcoal found adjacent to a Hope variety San Patrice point yielded an uncalibrated AMS age of 10,185 ± 75 B.P. (AA-26653). Other radiocarbon ages from this late Paleoindian horizon indicate that it was deposited between about 10,500 and 10,000 B.P.

A large amount of lithic manufacturing debris, preform rejects, and production failures was found in the 3Ab horizon, indicating the presence of a lithic-workshop area. Peak debris densities were centered stratigraphically at about 295–310 cm bs, or within the middle of the 3Ab horizon, throughout most of Blocks B-D. The highest artifact density (screened) within the 3Ab horizon was 1,499 flakes per m^3. The abundance of workshop debris may be obscuring residues of other activities, or it may be that other parts of the site hold more evidence of domestic activities. Such domestic areas may exist both to the east and west of Blocks B-D and perhaps once existed to the south prior to erosional destruction.

Sixteen debitage features were recorded in the 3Ab horizon, all of which consist of dense concentrations of waste flakes and occasional broken preforms. These lithic features are interpreted as collected piles of knapping debris (presumably swept or dumped piles); most exhibited a mounded profile and measured only 20–40 cm in diameter. They represent discrete episodes in the lithic reduction of one or more chert cobbles. Most of these cobbles were selected from secondary deposits of a particularly high-quality, fine-grained variety of Jefferson City chert. Manuported gravel piles were also common, but the function of these remains unclear.

Earlier Paleoindian artifacts were recovered from the 3Btb1 horizon immediately below the base of the 3Ab horizon. The oldest diagnostic artifact recovered in 1997 consisted of two refitted fluted-point fragments found at 330–331 cm bs. This has been tentatively identified as a Gainey point; it is strongly suspected that it is Middle Paleoindian given its stratigraphic location and an associated radiocarbon age of 10,700 ± 200 B.P. One well-made blade fragment also was found at 333 cm bs near the refitted fluted point. Although the blade fragment is undiagnostic, two flake scars evident on one face appear to represent overlapping flute scars. In general, relatively few tools were recovered from the upper part of the 3Btb1 horizon in levels associated with the Gainey point. However, lithic-artifact density within the fluted-point horizon is relatively high. Based on unscreened material, the density of flakes was 493 per m^3. Radiocarbon ages for charcoal found about 16–17 cm below the fluted point suggest the presence of cultural materials dating to both Middle Paleoindian and Early Paleoindian times. Six of eight AMS ages from this horizon range from 10,700 to 11,400 B.P.

Artifacts were also recovered below the Gainey point, although their numbers decrease greatly below about 350 cm. The density of artifacts at 350–390 cm is estimated as 30 per m^3, although this is likely too low since it is based on materials recovered by shovel-skimming only (i.e., not by screening). At least some of these artifacts appear to be in situ. For example, three large manuports were found at a depth of 365–377 cm. In addition, one in situ flake was recovered directly above an extensive gravel bed that was located 380–395 cm below surface. The 10–20-cm-thick gravel bed extends across a large portion of Blocks B and C, effectively sealing most potential cultural deposits located below about 395 cm. Charcoal from immediately above this gravel bed had an age of nearly 12,000 B.P., whereas two of three dates below the gravel bed indicate that it was deposited sometime after ca. 12,700 B.P.

The research potential of the Big Eddy site is vast, particularly in the case of the Early Archaic, Paleoindian, and possible pre-Clovis deposits. Unlike the often mixed strata of rockshelters and caves, open-air sites in rapidly aggrading alluvial environments provide the potential to isolate es-

sentially intact, structurally diverse, successive single-component assemblages. More controlled excavations of the deeper deposits at the site (i.e., those within the lower part of the middle Rodgers Shelter submember and within the entire early submember) could provide extremely important data needed to: (1) delineate an Early Archaic projectile-point chronology, (2) study activity areas in the Late Paleoindian horizon other than the flintknapping workshop, (3) collect much valuable and sorely needed subsistence and paleoecological data, (4) determine changes in depositional environments and sedimentation rates represented at and near the site, (5) tease out possible Middle and Early Paleoindian components and define their structural characteristics, and (6) obtain more definitive evidence for the presence or absence of one or more pre-Clovis cultural horizons.

Our excavation and analytical efforts were focused on the Paleoindian deposits at the site, but this is not meant to denigrate the importance and great potential of the later Holocene deposits for evaluating cultural chronology, past lifeways, and adaptational change. Nevertheless, the following sections mainly summarize our current thinking on the Paleoindian and pre-Clovis manifestations represented at the Big Eddy site, providing a broader context for evaluating the importance of our findings and prospects for future research.

Chronostratigraphic Findings and Future Potential

As Haynes (1993:219) remarked, "whereas surface finds of Clovis points occur throughout North America south of the Wisconsin glacial margin, sites *in situ* with stratigraphic context are rare, there being only 18 plus three probables." This has changed somewhat more recently, but it is still true that the vast majority of such sites are located in the Southwest and High Plains regions, stretching from western Texas to Montana. Haynes (1993:223) noted that "there are only five radiocarbon-dated fluted point sites in eastern North America [with] four of these [dating] between 10,590 ± 50 B.P. for Debert, Nova Scotia, and 10,190 ± 300 B.P. for Templeton in Connecticut."

The Big Eddy investigations have resulted in several radiocarbon "firsts" and provide a generally reliable sequence based on a relatively large number of AMS, standard, and bulk carbon age determinations. Within the early Rodgers Shelter submember, there would appear to be some vertical and horizontal mobility of small-scale debris, as some of the dates are stratigraphically inconsistent. This can be expected, however, particularly for small debris. However, the inconsistency could also be due to the abnormally large fluctuations in atmospheric ^{14}C at the close of the Pleistocene (Fiedel 1999). Overall, the dates on pre-Clovis, Paleoindian, and Early Archaic deposits confirm the general integrity of the artifact-bearing deposits and of the stratigraphy within the sites's early Rodgers Shelter submember.

Despite the few stratigraphically inconsistent radiocarbon ages, the dates and stratigraphic occurrences of artifacts indicate that the site has the potential to resolve many questions dealing with the Early, Middle, and Late Paleoindian periods. The Big Eddy site has unprecedented potential for discriminating diagnostic artifact assemblages and various aspects of changing settlement-subsistence strategies for these periods. Postdepositional movement of microdebris is evident, but larger artifacts, particularly those chipped-stone items and other materials relating to tool production and use, have moved little within at least the upper two-thirds of the Paleoindian deposits.

The evidence for the presence of pre-Clovis culture-bearing deposits at the Big Eddy site is inconclusive. Nevertheless, pre-Clovis-age deposits are present, and what appear to have been in situ artifacts (debitage and manuports) were recovered from deposits that probably date as early as ca. 11,900 B.P. Unfortunately, the single AMS date obtained from atop the gravel bed has a large standard deviation. These deep deposits were barely sampled, and much additional, careful excavation is needed to demonstrate that such materials are indeed pre-Clovis or, if not, certainly Early Paleoindian. Such excavations should include piece plotting of artifacts and other materials, including charcoal, and the processing of many additional AMS samples.

Reliable dates have been obtained from the Big Eddy site for Williams, Smith-Etley, Wilson, San Patrice, Dalton, and Gainey bifaces. Except for the Williams points, however, in situ diagnostic bifaces were uncommon in the sampled portions of the site, and several point types represented in private collections have yet to be found in situ. Particular point types for which reliable radiocarbon assays are sorely needed include Packard, Graham Cave, Rice Lobed, Searcy, Hidden Valley, Jakie Stemmed,

and Cache River. The relatively rapid aggradation of deposits within portions of the site make Big Eddy ideal for defining the relative stratigraphic position of such diagnostic bifaces, and the presence of scattered bits of charcoal throughout these deposits further heightens the potential for obtaining a reliable calendrical biface chronology for this portion of the midcontinent.

The most reliable dates from virtually all Paleoindian sites in the Northeast and Great Lakes regions, where deeply concave fluted points are predominant in early contexts, typically postdate 11,000 B.P., with most having ages younger than about 10,700 B.P. (Levine 1990:Table 1; Meltzer 1988:Table III; cf. Tankersley et al. 1997). The vast majority of existing dates have been obtained by conventional means and exhibit relatively large standard deviations. Yet, even the limited number of AMS dates from some sites in New England (e.g., the Vail site in Maine and the Whipple site in New Hampshire) conform to this pattern. By and large, most of the early dates from the Northeast are roughly contemporaneous with those from Folsom sites, i.e., later than those obtained from most Clovis sites in the Southwest, southern Plains, and High Plains. Likewise, some of the dates from the upper part of the 3Btb1 horizon at the Big Eddy site, where the full facially fluted Gainey point was recovered, seem to support the likelihood that this specimen and these deposits date to the Middle Paleoindian period. At least two of the three known fluted points in private collections also exhibit full facial flutes and one is Folsom-like, herein identified as an Eastern Folsom/Sedgwick point. The lone exception may be the small proximal fragment in the T. Collins collection (see Chapter 8). It is possible that this point base, which is slightly constricted and less concave than the other, more complete, specimens is representative of Clovis and the Early Paleoindian period.

Dates for fluted-point assemblages in the Southeast are considerably fewer and generally controversial, despite the abundance of fluted-point sites in this large region. As Anderson (1995b:149) noted in a recent overview, "there are still no reliable radiocarbon determinations on early fluted point assemblages from the Southeast." In the past four to five years, this situation has changed somewhat, but definitive evidence for the earlier part of the Paleoindian period is still lacking. Although the Big Eddy site is not located in the heart of the Southeast, it is situated on its western edge. Furthermore, the dates from the Big Eddy site are relevant to Early Paleoindian developments in the Southeast, and information from the site itself could provide a sorely needed bridge between the richer records of areas east (the Great Lakes and New England) and west (the High Plains, the southern Plains, and the Southwest) of the Mississippi River.

Implications from Big Eddy for Paleoindian Adaptations

As Chapter 3 briefly discussed, Paleoindian settlement and resource-procurement strategies are typically evaluated with respect to various sources of high-quality chert. This is largely a consequence of necessity, since nonperishable lithic debris is often all that survives at most Paleoindian sites in eastern North America (Meltzer 1993:295–298).

The overwhelming amounts of flintknapping debris found within Blocks B-D may have obscured indicators of other activities that were undoubtedly undertaken at the Big Eddy site by Late Paleoindian peoples. However, we do not know if these other activities were actually performed in the workshop area. The presence of scattered bits of charcoal and heat-fractured lithic artifacts and alluvial pebbles indicates that heating and/or cooking fires were used during at least Middle and Late Paleoindian times. It can be argued that this evidence alone is suggestive of multiple uses of the site. In other words, the Big Eddy site was not just a workshop locus for flintknappers engaged in retooling during brief visits to the site. Rather, it was probably a residential site or camp where a wide array of activities was undertaken during the approximately 1,500-year Paleoindian time span represented at the site. As discussed in Chapter 8, it seems likely to expect that other, unsampled portions of the site contain clearer evidence for the full suite of domestic activities. Paleoindian sites are typically well structured, and it seems likely that activities such as food processing, cooking, socializing, sleeping, and so forth would have been undertaken in parts of the site other than the workshop area. Although preservation of biological remains is poor, medium to large mammal bone, a possible acorn shell fragment, wild grape seeds, and chenopod seeds are represented in the Paleoindian deposits.

An assertion that the Big Eddy site was a residential locus during at least Middle and Late Paleoindian times is also supported indirectly by other

forms of evidence. According to Binford (1979:263), "the discard of personal gear related to the normal wearing out of an item was generally done inside a residential camp, not in the field where the activity in which the item was used occurred." If this assumption is correct, then occurrences of such items as exhausted end scrapers, adzes and polished adze flakes, and gravers, which were found within the workshop area and on the cutbank immediately to the south, imply that the site indeed served as a residential camp. Certainly, the disproportionate number of proximal projectile point/knife fragments (i.e., bases) relative to distal fragments (tips) is a good indication that at least some of the still-hafted, impact-fractured bases were brought back to the Big Eddy site, where they were unlashed and discarded or recycled. New bifaces, many of which were undoubtedly produced at the site based on the amount of late-stage manufacturing debris, were then lashed to the shafts or foreshafts of spears or to the handles of other implements.

The intensive utilization of the Big Eddy site throughout Paleoindian times and later must have been due to its optimal location with respect to a set of alluring factors, not just because the immediate locality contained high-quality Jefferson City chert. The presence of excellent raw material was certainly an important factor affecting frequent use of Big Eddy from at least ca. 11,500 B.P. to 8000 B.P. or thereabouts. However, alluvial deposits of Jefferson City chert were available throughout the middle and lower portions of the Sac River valley. Furthermore, such an argument does not explain the continued use of this locality during later periods when residual Burlington chert (a resource considerably more widespread in distribution) was the dominant resource exploited.

Intensive use of the Big Eddy site during Paleoindian times can be attributed partly to the elevated landform that existed here relative to other topographic features within this floodplain locality. Nonetheless, it should be noted that such topographic highs may have been present in other parts of the Sac River valley. Thus, it alone could have comprised a relatively weak determinant of site selection, as there may have been other similar topographic features available for occupation. Its attractiveness over many other elevated locations was perhaps enhanced by the fact that it was located directly adjacent to the river.

In turn, the common presence of buried late Pleistocene–very early Holocene landforms and the recovery of Paleoindian points by collectors suggest that Late Paleoindian sites may be scattered throughout the valley. In other words, the Big Eddy site's early components may not be that unusual for the lower Sac River valley, and perhaps there are many other sites that were intensively utilized during at least Late Paleoindian and/or Early Archaic times that remain buried and therefore hidden from view. In addition to the nearby Montgomery site, local artifact collections indicate that Late Paleoindian sites are fairly common, although Early and Middle Paleoindian sites may be rare.

Recent evidence also has been obtained that a spring may have been located in the vicinity of the Big Eddy site during at least late Pleistocene times. This evidence consists of the recovery of a piece of tufa from the large eddy pool adjacent to the site. Tufa is "a chemical sedimentary rock composed of calcium carbonate, formed by evaporation as an incrustation around the mouth of a spring, along a stream, or exceptionally as a thick, concretionary deposit in a lake or along its shore" (Bates and Jackson 1976:539). In addition, it can be assumed that the Big Eddy area probably was a relatively rich locality for hunting, trapping, gathering, fishing, and musselling.

Dincauze (1993b:284) defines two types of sites—"workshop-habitation sites" and "small single-unit fluted point sites"—as typical of unglaciated portions of eastern North America. So-called "residential sites," which are characterized by discrete multiple artifact clusters believed to represent the activities of families that camped together, are common in the glaciated regions but essentially unknown to the south. It could be argued that such sites do in fact exist commonly in unglaciated eastern North America. Quite conceivably, workshop-habitation sites and residential sites are one and the same, except that the former are also characterized by an abundance of flintknapping debris. Clusters of artifacts representing household-level activities have not been found at so-called workshop-habitation sites because: (1) they are obscured by the vast amount of lithic debris, (2) excavation methods have been too coarse, and (3) a relatively small number of such sites have been examined to date and most excavations have been inadequate in terms of spatial extent.

Sites with dense artifact concentrations are few and far between in the unglaciated regions, perhaps because most are also deeply buried in alluvium and hidden from view in major river valleys.

Given the integrity of the early cultural deposits at the Big Eddy site, it is expected that, if present, artifact clusters representing individual households can be detected. It is likely that these clusters will be most apparent away from the primary locus or loci of flintknapping. The definition of such artifact clusters will require the excavation of a relatively large area involving fine-scale provenience controls and the piece plotting of tools.

Paleoindian Mobility

In general, sites located in more northern, glaciated portions of eastern North America are typified by relatively large proportions of exotic materials, whereas those in the southern, unglaciated areas are typified mainly by local materials. The presence of exotic materials at sites in glacial areas, where chert and other knappable materials are typically of poor quality or nonexistent, most likely reflects direct procurement by highly mobile groups. Conversely, the paucity of such exotic materials at sites in the unglaciated regions, where chert is abundant and sometimes fine grained, may have little to do with mobility strategies. Rather, the paucity of exotics could simply result from the more widespread availability of local raw materials, with lowered needs to curate tools since they could be produced more readily in varied, known (and therefore scheduled) places on the landscape. The Big Eddy site fits this pattern, as less than 1% of the lithic debris is composed of exotic or nonlocal material. The site's location in an area having multiple high-quality resources and with chert-poor regions on either side makes the Sac River valley a good area to test such ideas.

Previous investigations of exotic-material acquisition have not resulted in answers to questions about direct vs. indirect procurement, since mutually exclusive forms of evidence are extremely difficult to define. Despite the absence of clear empirical evidence for discriminating either form of procurement, most contend that direct procurement, whether by primary expeditions to the sources or as an embedded activity, was a more likely (or more common) practice among Paleoindian hunter-gatherers (Goodyear 1989:7; Meltzer 1989). Of course, the presumption that Paleoindian groups were highly mobile lends itself to such circular interpretations. In addition, the conception that Paleoindians were initial colonizers in some contexts (e.g., Dincauze 1993b:281–284) also provides a basis, though unsupported, for invoking models of high mobility and direct procurement.

Although limited in relative quantity, the array of represented exotic raw materials at Big Eddy indicates movements of chert and/or people in multiple directions, particularly during at least Late Paleoindian times. During the Late Paleoindian period, much of the exotic raw material was derived from the upper White River basin south of the Ozark Divide at a distance of about 110–200 km. These consist of four Mississippian cherts: Lower Reeds Spring, Middle Reeds Spring, Red Pierson, and Pitkin. Exotic Pennsylvanian material also was procured from the eastern Plains some 130–240 km to the west and northwest (Winterset chert and three other unidentified Pennsylvanian cherts). Exotic materials are considerably more meager for the Early/Middle Paleoindian components, but this is probably a function of differences in sample size. In any respect, the evidence also indicates procurement of at least Lower Reeds Spring chert to the south, and one may assume that future excavations will result in the recovery of other exotic materials from sources located in other areas.

The sheer distance of these sources from the Big Eddy site may provide the evidence for at least some limited exchange of exotic commodities, at least during the Late Paleoindian period. For example, Lothrop (1989:119) observed that six of nine exotic resources represented at the Potts site in New York "embrace a geographic area of 3–400,000 sq km over parts of New York and Pennsylvania." He further notes that this "estimate exceeds by 200,000 sq km the annual ranges reported for several hunter-gatherer groups, including those of northern regions" (Lothrop 1989:119). As such, he contends that some exchange must of have occurred, followed thereafter by an attempt to define which exotics were exchanged based on relative percentages of lithic types among the tools and debitage.

This general argument would appear to be useful for determining if exchange had taken place. However, at least four assumptions must be made, and each of these reduces the potential adequacy of arguments for exchange. First, it must be assumed that each of the exotic materials has been correctly identified as to a specific source. Second, it assumes that the Paleoindian groups were not new colonists but rather had resided in the area for some time and had established moderate-sized territories and seasonal rounds. Third, it assumes that Paleoindian activities fall well within the range of activities for

ethnographically documented hunter-gatherers. Finally, it assumes limited fluidity in band membership; that is, members from one band, who may have possessed tool kits containing items made of exotic raw material, would rarely if ever join another band. This last assumption, however, is not supported by ethnographic data (Ingold et al. 1988a, 1988b). It is argued here that at least the first two are met for the Late Paleoindian component(s) at the Big Eddy site. That is, the raw-material identifications have been made with a great degree of confidence and the Late Paleoindian groups utilizing the Big Eddy site were clearly not the original colonizers. It is also possible that the temperate forest ranges of those Late Paleoindian groups at Big Eddy were smaller than the norm for most regions, even those northern regions occupied in the recent historic past (see Kelly 1995:Table 4-1).

Some researchers have argued for a general reduction in the distance of procurement from Early Paleoindian to Late Paleoindian times (e.g., Tankersley et al. 1990). By Late Paleoindian times, it seems logical to predict such a reduction as the consequence of an increase in population density and a concomitant reduction in the spatial extent of land tenure. This follows from the general argument that "if population size is small, groups may be highly mobile and territorial ranges wide and open. Access to a specified resource is unlikely to be restricted and thus procurement may be direct" (Curran and Grimes 1989:44). As population grew, groups would have witnessed a decrease in direct accessibility to distant exotic resources, and the likelihood for exchange of such resources would therefore increase. Such a change in exotic-resource acquisition due to population growth could have characterized the transition from Early Paleoindian to Late Paleoindian times, or from Clovis to Dalton times, in the Midwest. As O'Brien and Wood (1998:92) note:

> What has long struck us is the frequency with which Dalton points occur in museum and especially private collections. While there is no way of even predicting the number of points that have been found, it eclipses the number of Clovis and Folsom points by at least several orders of magnitude.

A similar numerical increase is apparent in the Larry Brown collection (most of which is curated at the Center for Archaeological Research), which contains about 25,000 bifaces from sites mainly in Christian, Greene, and Webster counties in southwest Missouri. This massive collection includes the bases of only two or three fluted Early/Middle Paleoindian points and examples of over 60 Late Paleoindian Dalton points. Despite the absence of good systematic survey data, it can be stated with a high degree of confidence that substantial population growth had occurred by the beginning of and continued during the Late Paleoindian period in the Ozarks and along its periphery. As such, direct access to distant sources may have become more and more restricted simply because the landscape was being packed with more and more people.

The suggestion that exchange occurred during at least Late Paleoindian times probably will never be resolved entirely. We contend that most, if not all, of the Mississippian cherts from sources to the south probably arrived at the Big Eddy site as a result of direct procurement. Nonetheless, the co-occurrence of artifacts representing two (and perhaps three) presumably separate but contemporary cultural complexes (Dalton and San Patrice) adds a potentially unique twist to the arguments of direct vs. indirect procurement. The possibility that the Big Eddy site served as a rendezvous location for different groups has been raised in Chapter 9. If this were indeed the case, then exotics from the south could have been procured directly by other people who brought these materials (or tools made from them) to the Big Eddy site for exchange. A similar system could have been established with western Dalton (Meserve) groups on the eastern Plains. While a possibility, such a scenario represents a great interpretive leap and one that cannot be proven conclusively with the existing archaeological data.

Early Paleoindian or Pre-Clovis?

The possible presence of pre-Clovis or even very early Early Paleoindian cultural activities at the Big Eddy site has important implications for the timing and pace of the colonization of North America. The site's importance is partly geographic, as it occurs in the south-central part of North America, relatively far inland. The distances to the East and West Coasts are substantial, and mountain ranges perhaps provided intervening impediments to rapid inland colonization, particularly if a forgiving ice-free inland corridor was not used as a route for initial interior penetration of the North American midcontinent. If positive evidence of a pre-Clovis

occupation is found at Big Eddy, it will not be representative of the earliest North American founding population, but rather that of the initial colonizing group in the western Ozarks or even the descendants of people that had long colonized the area.

Proponents of the "Clovis-first" hypothesis are gradually waning in numbers, but the most skeptical still perhaps have reason to believe that unimpeachable proof of pre-Clovis occupation has not yet been obtained. The origin of the fluted-point tradition itself remains contentious, as the only "fluted" specimen known from Siberia is difficult to reconcile with Clovis fluted specimens. The center of the fluted-point tradition could be placed in southeastern North America, where the abundance and diversity of fluted points appear to be greatest. However, this also does not fit the model of the colonizing foragers of Clovis peoples spreading from west to east from some gateway located in the area of the lower Missouri and central Mississippi valleys. Alternatively, a few researchers have recently advanced the hypothesis that fluted-point technology in eastern North America may have even been derived from an earlier Solutrean center in western Europe, as there appear to be many parallels between the two complex bifacial technologies. Such a model, however, ignores the possibility of convergent technological evolution and assumes that a resident population was not present or that, if present, they were incapable of independently developing such a technology. This criticism is not designed to demean a "Solutrean-base" hypothesis, as it too requires careful consideration.

A commonly favored scenario today is that the founding population entered North America as sea-mammal hunters during the late Pleistocene if not earlier (perhaps ca. 30,000–40,000 B.P. to even as early as 70,000 B.P.), rather than as hunters following megafauna over the Bering land bridge and then through an inland corridor, arriving on the Plains where they quickly began to propagate and saturate the Western Hemisphere. Questions have been raised recently regarding the ability of humans to directly enter the interior North American midcontinent after glacial wastage began about 15,000 B.P. until about 10,000 B.P., when the glaciers had largely retreated from the area, since this period was marked by a general lack of vegetation needed to support resources that would have provisioned prolonged human travel (e.g., Beierle and Smith 1998). A western route along the coast of the Bering land bridge during glacial maxima, or even through the Bering Straits via seaworthy watercraft during glacial minima, has come into vogue as the most commonly favored model for the early peopling of the Americas.

Archaeological evidence from Big Eddy for pre-Clovis or very early Clovis (ca. 11,500–12,000 B.P.) is so far wanting, but this may be largely due to the limited extent of the excavations in the deepest deposits. In all likelihood, the lower Sac River valley in general and the Big Eddy site in particular were utilized by earlier peoples than those represented by debris in the Early/Middle Paleoindian deposits. This assertion derives from preliminary archaeological evidence and from consideration of extant models of colonization. If Clovis-like groups were the first to settle in the region around 11,500 B.P., then an ample amount of time should have passed for the progeny of any founding population from the west coast to cross the Rocky Mountains and the Plains, refocus their adaptation on inland hunting and gathering, and quickly adapt to a multitude of changing environmental conditions and diverse biotic communities. Given that some of the earliest groups were of an exploratory nature and adaptations to "megapatches" allowed relatively uninhibited large-scale residential movements, it seems unlikely that one such group, foraging over a very thinly populated panregional landscape, would become tethered specifically to the Big Eddy locality immediately after entering the region. The small amount of exotic materials in the Early/Middle Paleoindian deposits dating to 10,700-11,400 B.P. indicates that the Big Eddy occupants were almost entirely reliant on local resources and therefore must have already known the area well. In other words, people probably had been there before, perhaps several hundred if not a thousand or more years earlier, or there was at least some period of "settling in" intraregionally before the Big Eddy site became a frequently used residential locus around 11,400 B.P.

The collection of a large suite of radiocarbon assays and careful excavation of deposits below about 350 cm bs to about 390 cm bs are particularly crucial to addressing the issue of early Early Paleoindian and pre-Clovis, at least in regards to the deposits overlying the gravel bed. This is partly be-

cause we have only one radiocarbon age with a large standard deviation from the top of the gravel bed at 384 cm bs, with no ages between that depth and 347 cm bs. This alone obviates making any conclusive statements regarding artifacts found within this transitional zone. It is within these deposits that the possible transition from pre-Paleoindian (or pre-Clovis) to Early Paleoindian should be present, if we assume that the Paleoindian period is first represented in this area around 11,500–11,600 B.P. Although the possibility of pre-Clovis has been suggested, it is also quite possible that virtually all of the artifacts could be very early Early Paleoindian and unrelated to an earlier, technologically distinctive culture. Furthermore, other than the three manuports found at 365–377 cm bs and the possible fluvially redeposited flake found atop the gravel bed, essentially all of the artifacts found below about 350 cm bs to the top of the gravel bed could represent displaced materials from the Early/Middle Paleoindian horizon represented at about 330–350 cm bs.

The presence of only a handful of largely debatable pre-Clovis sites in North America is probably due to at least three primary factors. First, the archaeological visibility of such sites may be exceedingly limited. Not only could such sites be restricted in number and perhaps extent, but finding them would require good knowledge of late Pleistocene landscapes. Some of the most favorable places for human activities or even habitation may be deeply buried (if they have not been eroded away), or they may occur in places that are rarely examined by researchers biased by later prehistoric data. Second, archaeologists will have a difficult time recognizing, much less searching for, pre-Clovis if they are blinded by preconceived notions of what should or should not exist. A "Clovis-first" adherent will have an extremely difficult time accepting pre-Clovis sites in the Western Hemisphere. That is, if pre-Clovis exists, one will not find it if one does not search for it. Third, the artifactual content of a pre-Clovis site may be extremely difficult to recognize, and it might be quite different from what one might expect for a technology that spawned Clovis or, perhaps more likely, one which Clovis overwhelmed. Some of the earliest potential pre-Clovis sites are suggestive of an emphasis on the use of biological materials such as bone, ivory, antler, wood, and other plant tissues rather than a highly formalized chipped-stone technology.

The point we make here is that it is incumbent for any researcher interested in the possibility of pre-Clovis to maintain an open mind about what to expect (see Bryan 1986). The beginning of any search requires the identification of pre-Clovis landform-sediment assemblages, and information about coeval conditions must also be obtained. In the case of Big Eddy, a pre-Clovis-age landform-sediment assemblage is present and immediately overlain by deposits exhibiting abundant evidence for human use of this location. Given the presence of such a landform and the apparent attractiveness of the locality during later terminal Pleistocene and early Holocene times, there is good potential for locating evidence of pre-Clovis activities. This includes those deposits immediately above the gravel bed and those deposits extending from the base of the gravel bed down to the top of the gravel bar substratum. Consequently, the pre-Clovis-age deposits at the Big Eddy site should be adequately investigated to obtain more definitive evidence for the presence or absence of one or more pre-Clovis cultural horizons.

RECOMMENDED FUTURE INVESTIGATIONS AT THE BIG EDDY SITE

The following represents a list of problems and research domains that should be examined by additional work at the Big Eddy site.

- Define diachronic rates of alluvial aggradation throughout various sections of the late, middle, and early Rodgers Shelter submembers.
- Expand the excavation of Feature 2 to determine if it is indeed a prehistoric structure or simply a natural charcoal deposit.
- Examine the potential for stratigraphically defining Middle Woodland and Early Woodland components within the upper part of the thick late submember in the western part of the site.
- Explore the potential for stratigraphically defining two or more Late Archaic components within the lower part of the thick late submember in the western part of the site.
- Expose and thoroughly sample the middle Late Archaic midden and search for related features, including possible structural remains.

- Attempt to delineate stratigraphically Middle and Early Archaic components in the middle submember in the central part of the site.
- Obtain larger artifact samples for late Early Archaic, Middle Archaic, early Late Archaic, late Late Archaic, and possible Early-Middle Woodland components.
- Determine more precisely the northern and eastern extent of the early Rodgers Shelter submember.
- Attempt to locate activity areas in the Late Paleoindian horizon other than the workshop, including the testing of Paleoindian deposits on the east end of the site some 60–70 m east of Blocks B-C.
- Perform more careful excavation and systematic sampling of Late Paleoindian knapping features and manuported gravel piles.
- Search for Early/Middle Paleoindian in the vicinity of Block D.
- Tease out possible Middle and Early Paleoindian components and define their structural content.
- Seek definitive evidence for the presence of one or more pre-Clovis cultural horizons.
- Obtain and date more AMS and standard radiocarbon samples from all investigated components.
- Enlarge the collection of flotation samples and undertake more extensive and intensive archaeobotanical analyses, including some scanning electron microscopy.
- Collect more carbon isotope data and complement these with phytolith data.
- Undertake a more thorough assessment of pollen preservation.
- Endeavor to collect bone from the Paleoindian deposits and undertake DNA analysis if possible.
- Undertake microwear analysis on selected samples of artifacts.
- Conduct trace residue analysis on selected samples of tools.

Our provisional recommendations for future work, both at the site and within the lower Sac River valley, are presented below. First and foremost, it is emphasized that an interdisciplinary investigation is mandated. Every effort should be made to conduct the recommended investigations—geoarchaeological, paleoecological, and archaeological—in an integrated and complementary manner. The proposed work should be undertaken on a multistage basis and will undoubtedly involve several years of ongoing effort. Because of the active and accelerating site destruction due to cutbank erosion, on-site investigations at Big Eddy should be conducted first.

Geoarchaeological Investigations

Geoarchaeological investigations should consist of detailed stratigraphic investigations at the Big Eddy site and the immediate vicinity, followed by exploratory evaluation of the broader alluvial stratigraphic context for early cultural deposits in the Sac River valley. The focus of these activities should be on the earlier Paleoindian and pre-Clovis deposits, but not to the exclusion of defining later deposits.

Initial investigations have established a provisional stratigraphic framework and an outline of the depositional environments for the Big Eddy site. Paleoindian deposits are situated on a former point-bar complex on a slight rise created by an underlying gravel bar. Cores, trenches, and excavations indicate the former stream bank trends north-northeast, but its extent and the extent of the early Rodgers Shelter submember and associated Paleoindian material are still poorly known to the east, northeast, and north-northeast. Because the site occurs on the west side of the valley, it is possible that the entire floodplain area east of the site could be underlain by the same stratigraphic unit. The geometry of the strata containing Paleoindian cultural material and the limits of the Paleoindian cultural deposits should be traced to the east, northeast, and north-northeast in core and trench transects. The buried stream bank also should be traced by a series of short core transects and limited trenching at right angles to the projected strike of the bank.

At least one detailed core and trench profile should be constructed in a transect to the eastern valley wall in order to place the Big Eddy site within a local valley context. Additional coring and trenching should be conducted in the vicinity of this transect if the initial coring indicates the likelihood of buried spring deposits appears strong (see below). If such deposits are encountered, they will be sampled for appropriate paleoenvironmental data.

The results of our preliminary investigations raised a number of site-specific stratigraphic questions and problems. For example, what is the degree of stratification within the Early and Middle

Paleoindian deposits? Are the cultural materials below the "Clovis" cultural deposits definitively in situ, and therefore truly pre-Clovis, or can they be explained by some pedoturbation processes? Why is there such a scatter in the radiocarbon ages of small charcoal samples associated with the Early/ Middle Paleoindian deposits in the 3Btb horizon? Finally, over what intervals of time did Buried Soils 1 and 2 develop, and to what degree did soil and depositional processes interact?

The microstratigraphy, formation processes, and integrity of the Archaic through pre-Clovis cultural deposits should be refined through additional detailed descriptions and analyses of sediments and soils in archaeological excavation units, coupled with specific archaeological excavation and sampling strategies. These should include, but not be limited to: (1) the orientation of excavation units in accord with the Paleoindian landscape, (2) excavating in thin levels in accord with the strike and dip of the paleolandscape (i.e., in natural levels) for microstratigraphic resolution, (3) measurement of the strike and dip of several size-grades of objects, and (4) sampling to assure integration of stratigraphic data with vertical variability in debris densities for different size fractions of artifacts. All cores, trenches, and archaeological excavation profiles should be described utilizing standard pedological and sedimentologic techniques and terminology.

We propose to conduct micromorphological analyses on soils developed in all of the alluvial stratigraphic units at the Big Eddy site. The purpose of the micromorphological analyses is to determine the degree of pedogenesis in the surface and buried soils at Big Eddy. This information may be used to infer the duration of different episodes of landscape stability represented by the buried soils. It may also be used to assess the weathering intensity and characteristics of soil-forming environments at Big Eddy during the Holocene and late Pleistocene. An understanding of soil evolution at the site is critical to an understanding of site-formation processes, especially those that affect the vertical and horizontal integrity of cultural deposits.

Specifically, at least one undisturbed thin-section and X-radiograph sample should be collected from each soil horizon at the site. Thick horizons would require additional sampling (typically two to three samples). The samples would be collected from a vertical profile that spans the Holocene and late Pleistocene deposits exposed in archaeological excavation blocks. The soil samples should be sealed in protective containers immediately after removal.

The majority of AMS radiocarbon ages are in stratigraphic order, but some are not. The preference is to date large quantities of charcoal from features using standard techniques. However, the 1997 excavations have shown that, at least for the Paleoindian deposits, such organic features will be very rare if they are present at all, and it will be necessary to continue relying upon dispersed, small charcoal fragments that require AMS dating. Therefore, more selective and controlled sampling of the dispersed charcoal at the site will be required to determine a reliable and detailed geochronology. In addition to evaluating the microcontext of individual charcoal fragments, samples will be measured with reference to stratigraphic contacts as well as depth below ground surface. Samples will be identified using a relatively high-powered microscope or, if necessary, a scanning electron microscope. In connection with assessing appropriate charcoal samples to submit for dating, a charcoal stratigraphy should be constructed for the site by identifying charcoal genera and species, if possible, and concentrations in flotation columns through the different submembers of the site.

It is also important to place the geomorphology of the Big Eddy site within a larger stratigraphic and paleoenvironmental context. This should be accomplished through a preliminary geoarchaeological investigation of the Sac River valley. The objectives in this area are twofold: (1) to begin to evaluate the stratification exposed in Sac River cutbanks and (2) to document stratigraphic situations in cutbanks similar to that exposed at the Big Eddy site with early prehistoric cultural deposits. A 100-km section of the lower Sac River valley should be surveyed by an archaeologist and a geomorphologist via canoe to locate and document all sites in eroding cutbanks. Each cutbank should be examined closely for buried cultural horizons and ^{14}C datable materials. Preliminary assessment of represented stratigraphic units should also be made. Locations and lengths of sites and cutbanks should be noted on 1:2,400 Corps of Engineers maps and 1:24,000 USGS 7.5′ topographic maps. Cutbanks with prehistoric cultural deposits in late Pleistocene and early Holocene contexts should be revisited and stratigraphically and pedologically described in detail. Attempts should be made to collect and submit initial suites of radiocarbon samples from

cultural deposits in stratigraphic positions that indicate the greatest likelihood of containing Middle Archaic, Early Archaic, Paleoindian, and pre-Clovis deposits.

Paleoecological Investigations

Our 1997 investigations have shown that future excavations at the Big Eddy site can contribute substantial information to the development of a well-dated paleoecological record for the late Pleistocene and Holocene periods in the western Ozarks and beyond. This is particularly crucial for understanding the adaptational changes represented at the Big Eddy site and in the region. Botanical, faunal, and pollen preservation apparently are not good, at least in the deeply buried Paleoindian deposits, but the collection of such samples should not be abandoned for several reasons. First, only a small part of the valley stratigraphic context was explored. Second, valley-margin springs and other valley-margin deposits, often good sources of paleoenvironmental data, might be present. Third, some information can still be obtained for these analytical domains by undertaking more labor-intensive types of sample recovery, processing, and analysis. Fourth, most of the deposits were not sampled for pollen, and at least some of the younger Holocene (and perhaps even older late Pleistocene) alluvium may exhibit sufficiently good preservation of these paleoenvironmental materials.

The carbon isotope data have demonstrated that much can be learned about paleoecological conditions during the terminal Pleistocene and the Holocene. With some additional carbon isotope analysis, supplemented by full-scale phytolith analysis, the data obtained for the late Pleistocene and the entire Holocene will fill an extremely important void in the paleoecological record for this region. In this regard, it is noted that paleoecological information for the terminal Pleistocene and much of the Holocene was essentially missing from the record for the nearby lower Pomme de Terre River valley, except as it has been inferred from the archaeological record at Rodgers Shelter.

Carbon isotope and phytolith sampling of the thickest parts of the early, middle, and late Rodgers Shelter submembers should enable the development of a relatively detailed paleoecological record encompassing the entire span of known human presence in midcontinental North America. For example, the thickest part of the late submember in the western part of the site has deposits about 5 m thick that encompass more than 4,000 years. Samples taken at 5-cm and/or 10-cm levels from these deposits, when combined with suites of radiocarbon assays and estimates of changing rates of sedimentation, could shed important light on paleoecological dynamics at 100–200-year increments or less. Palynological samples representative of larger sections of the three submembers also should be submitted early during the excavations to determine research potential and the need, if any, for more intensive sampling and analysis. At a minimum, at least two columnar series of samples for each type of analysis should be collected. These can be collected side-by-side, preferably adjacent to flotation columns.

Archaeological Investigations

Late Archaic and Woodland (Late Rodgers Shelter Submember)

The thickest part of the late Rodgers Shelter submember occurs in the western part of the Big Eddy site, and it is here that the potential for dating and defining individual post–Middle Archaic components is greatest. This is also the location of the buried middle Late Archaic midden deposit, only a small fraction of which was encountered in Block A. It is recommended that both intensive and extensive excavations be undertaken in the late submember to the west, northwest, and north of the former location of Block A following delineation of the midden by coring. These new excavations should be undertaken contiguous to Block A. The late submember in this location is over 5 m thick.

It is recommended that initially a minimum of six to eight units measuring 2 x 2 m be hand excavated. One quarter of each unit (a 1-x-1-m subunit) should be screened to provide control collections, while the remaining three-quarters could be carefully trowelled and/or shovel skimmed. The units should be spaced roughly evenly to the west, northwest, and north of Block A. Given the size of the buried middle Late Archaic midden deposit, most of these should be placed over that deposit. The hand excavations should begin at a depth of about 50 cm bs and should be continued to the surface of the middle Late Archaic midden deposit, about 230 cm bs. It is hoped that excavation of these units will result in the definition of Woodland and Late Archaic components postdating about 4000 B.P. As

with all subsequent work, every effort should be made to recover piece-plotted radiocarbon samples and columns of flotation and paleoecological samples (minimally carbon isotope, phytolith, and charcoal samples).

Upon completion of the hand excavations, trackhoe excavations should be undertaken to the surface of the middle Late Archaic midden unless dense occupational zones or features are discovered in the hand-dug units above this surface. If such deposits are found, an alternate strategy will be developed. Ultimately the entire middle Late Archaic midden deposit within the easement should be exposed, although this may not be feasible given that it may extend into the adjacent woods. Some exploratory trenching also should be undertaken to this approximate depth in search of any nonmidden habitation loci. Extensive screened hand excavations within the middle Late Archaic midden deposit should follow and include continuation of the original units. This sample should include careful excavation in no greater than 5-cm levels of at least 30–40% of the midden deposit, followed by shovel skimming in search of features and diagnostic materials. After the midden is adequately sampled and shovel skimmed, four to six additional 2-x-2-m units should be hand excavated to about 4.0 m bs, or almost 1.5 m below the midden deposit. This stage of the excavations could also employ subsample screening as described above. If nothing is found, work on this landform-sediment assemblage can be terminated.

Middle and Early Archaic (Middle Rodgers Shelter Submember)

The thickest part of the middle submember is located about halfway between Blocks A and B-C. Approximately 5 m north of the cutbank, a relatively large area should be stripped down to just above the top of the 2Ab or the T1b surface. Once the late Holocene overburden is removed, a minimum of six to eight units measuring 2 x 2 m should be hand excavated and screened. These units should be excavated from the T1b surface, or about 80–90 cm bs, to about 350–400 cm bs. Upon completion of the hand excavations and in the absence of other dense occupational zones or habitation features, trackhoe excavations should be undertaken to at least the same level as the base of the deepest hand-excavated unit. If nothing is found here, work on this landform-sediment assemblage can be terminated.

Additional investigations of the middle submember also should be undertaken in the central part of the site where the three submembers are stacked. We know from radiocarbon ages, geoarchaeological evidence, and the few diagnostic projectile points recovered in situ that this part of the site contains mostly Early Archaic cultural deposits. The deposits to the west are much thicker, but they may not be artifact bearing, or at least not as rich as those to the east because of differing landscape elevations. A large area should be stripped here to just above the T1b surface. The stripping should include the area between Blocks B-C and D, as well as some 30–40 m to the east of those blocks. Such a large area will need to be cleared anyway in anticipation of the deeper excavations into the early submember.

To obtain diagnostic artifacts, radiocarbon samples, and other types of samples (flotation and paleoecological), a 10-x-10-m block area and at least four to six units measuring 2 x 2 m should be hand excavated and screened (or sample screened). The block area should be located to the east of Blocks B-C. These hand excavations should extend down to the T1c surface. Upon completion of the hand excavations and in the absence of other dense occupational zones or habitation features, trackhoe excavations should be undertaken in relatively thin increments in the remainder of this large area to about 280 cm bs, or slightly above the T1c surface. The principal purpose of both the hand excavations and the stripping work is to obtain a larger sample of artifacts from the middle submember, particularly the lower part, as these should relate to transitional changes in technology and subsistence from the Late Paleoindian period into the Early Archaic period. At the same time, it should allow for chronostratigraphic delineation of several contemporaneous and/or successive Early Archaic components known to be at Big Eddy.

Paleoindian and Pre-Clovis (Early Rodgers Shelter Submember)

The proposed field work should expand on the excavations conducted in the summer of 1997. The principal objectives are: (1) to demonstrate conclusively whether the Late Paleoindian components (i.e., Dalton and San Patrice) are stratified within

the youngest increment of the early submember; (2) to search for additional Late Paleoindian components and/or diagnostic artifacts in the youngest strata (i.e., Wilson, Plainview, and Scottsbluff)); (3) to delineate stratigraphically if there are two or more Early and/or Middle Paleoindian components (e.g., Clovis, Gainey, and Eastern Folsom/Sedgwick) and their relationship; (4) to obtain a larger sample of artifacts from the Early/Middle Paleoindian levels to investigate changes in technology and subsistence; (5) to investigate transitional changes in technology and subsistence from Early Paleoindian to Early Archaic times (i.e., from Clovis/Gainey to Dalton/San Patrice to Graham Cave/Rice Lobed/etc.); (6) to determine the presence or absence of pre-Clovis cultural deposits in a sealed context below the Paleoindian deposits; (7) to piece plot and collect diagnostic artifacts, charred plant remains, faunal material, and other material remains; and (8) to obtain additional radiometric ages and paleoecological samples from the pre-Clovis, Early Paleoindian, Middle Paleoindian, and Paleoindian.

The proposed investigations should emphasize more extensive as well as more intensive work. The more intensive approach is necessary to overcome some of the shortcomings of, and to answer questions raised by, the 1997 investigations. The shortcomings include a major emphasis on shovel skimming with a limited amount of dry screening using 0.64-cm (0.25-in) mesh hardware cloth, relatively quick excavation of lithic features and gravel piles, and less than desirable information on the strike and dip of artifacts. However, it should be noted that these shortcomings were more than offset by our discoveries, which would not have occurred had we not progressed as rapidly in our 1997 excavations as we did.

The 36-m^2 area, representing the base of the 1997 excavations at a depth of 350 cm in contiguous Blocks B and C, should be reopened by removal of back fill using a large trackhoe and a front-end loader. This entire area should be carefully hand excavated to a depth of 450 cm. At that point, OHSA regulations would require creation of a step bench. Subsequently, a 16-m^2 area should be excavated to the gravel-bar deposits at about 500–550 cm below surface. The primary data-recovery unit should be 0.5-x-0.5-m subunits within 1-x-1 m units. To obtain fine control over the pre-Clovis and Early Paleoindian stratigraphy, careful excavations should be undertaken in no greater than 5-cm levels. The excavation of even thinner levels may be necessary to determine if cultural stratigraphy can be teased out within the Early/Middle Paleoindian deposits at Big Eddy. All lithic tools should be piece-plotted, left unwashed, and placed in zip-lock bags for future residue analyses.

The recovery of a variety of specialized samples will be critical for resolving questions about site formation, Paleoindian chronology, settlement-subsistence, and paleoecology. All excavated fill from the Early Paleoindian and pre-Clovis levels will be water screened on-site through 0.32-cm (0.125-in) and 0.64-cm (0.25-inch) hardware cloth. Continuous sediment columns should be collected from excavation units and/or block walls for potential flotation recovery of charcoal, faunal remains, and small lithic debris. Additional geoarchaeological sample columns, taken adjacent to flotation columns, should be collected for physical and chemical analyses; these samples should also be screened through nested sieves down to 0.25 mm to recover microdebitage and other inclusions. Continuous sediment columns should be collected minimally for analyses of particle size, organic matter, available and total phosphorus, pH, clay mineralogy, stable carbon isotopes, thin sections, X-radiography, and charcoal stratigraphy. All specialized samples (e.g., radiocarbon samples), features, and tools will be piece plotted using an electronic transit. All profiles should be mapped and described using standard soil and sediment techniques and terminology.

Following the completion of work in Blocks B and C, we propose three major block excavations, each 13 x 13 m in size, within the large area opened to examine the middle submember. These should consist of: (1) Block E on the east side of Block B, (2) Block F between Blocks B and D, and (3) Block G to the north of Block E and to the east of Block F. If sound evidence for pre-Clovis artifacts is found during the initial excavations in Blocks B and C, then all work shall proceed down to a similar depth. However, if nothing is found, then the work shall be terminated upon completion of excavations of the Paleoindian horizons.

The primary data-recovery unit should be 2 x 2 m in size. Finer control should be obtained by excavating each 2-x-2-m unit in four 1-x-1-m quadrants and, if considered necessary, in 0.5-x-0.5-m subunits. The hand excavations should entail careful shovel skimming and/or troweling in 5-cm intervals or less if deemed necessary. All excavated fill

from Paleoindian and pre-Clovis levels should be water screened on site through 0.32-cm (0.125-inch) hardware cloth. All specialized samples, features, and tools should be piece plotted using an electronic transit.

Finally, a small 10-x-10-m exploratory unit (Block H) should be excavated on the east side of the site (approximately 60 m east of Block E) near the location where at least one Dalton point was found on cutbank slumpage. Overburden should be removed to a depth of 290 cm, or the top of Buried Soil 1. On the 16-m^2 floor, one 2-x-2-m unit should be dug and water screened to the base of cultural deposits.

Field-Work Scheduling

Ideally, the proposed field investigations should be undertaken during the spring and/or fall. Because of the considerable depths and the fact that the artifact-bearing deposits are underlain by a gravel bar and sand, high water created by power-generation releases ultimately enters any deep excavations near the cutbank due to hydrostatic pressure. In 1997, following some initial problems with water seepage into Blocks B-C while working in the Paleoindian levels, power-generation releases were coordinated to avoid delaying archaeological excavations (e.g., releases in the late afternoon or evening), but this cannot always be assured. Unless suitable accommodations can be made, it is imperative that at least the deep excavations in reopened Blocks B-C be undertaken when the need for power-generation releases is minimal. If this cannot occur, then some form of ongoing pumping will be required. The necessary equipment should minimally include one 3-in trash pump per block area, with a backup pump available in the event of equipment failure.

Sample-Collection and Analytic Considerations

The recovery of a variety of specialized samples is critical for resolving questions about site stratigraphy and formation, Archaic and Paleoindian chronology, settlement-subsistence, and paleoecology. As noted above, all lithic tools should be collected and processed to assure their suitability for residue analyses. Besides piece-plotted radiocarbon samples, several large continuous columns of sediment samples should be collected from units and the walls of excavation blocks. These should be removed minimally for the recovery of small-scale plant and animal remains, as well as other micromaterial remains. In addition to flotation-recovered debris, all animal remains and plant remains not collected for dating (unless the density is deemed too high) should be piece plotted.

The presence of carbonized plant remains, including food remains, within the early and middle submembers makes the Big Eddy site extremely important. Nevertheless, archaeobotanical remains are poorly preserved within the deeper deposits at the site. In order to increase the sample of charred plant materials, the volumes of flotation samples should be enlarged substantially. These should be at least four times (minimum sample size of 25 liters) the size of many of those (6.25 liters) collected in 1997. In order to maximize recovery, a 5-cm level from an entire 1-x-1-m unit, which corresponds to 50 liters of sediment, could be collected for flotation. Efforts also should be made to devise a flotation method that minimizes the destruction of the already fragile plant materials. Preservation of faunal materials is also generally poor within the Paleoindian levels, but it is notable that a few small bits of bone were recovered from the Early Paleoindian levels. With greater caution during the excavation, it is anticipated that more bone could be found and perhaps identified by DNA analysis.

The Big Eddy site has great potential for refitting studies and, because the site has multiple Paleoindian components, for gaining temporal perspectives on changing technological trajectories and preferential exploitation of raw materials. Previous studies have demonstrated their usefulness for reconstructing production methods for chipped-stone tools (e.g., Bradley 1982; Storck 1983), as well as for assessing site-formation processes (e.g., Cziesla et al. 1990; T. Morrow 1996; Schiffer 1987). Future refitting efforts should be undertaken for all tool fragments as well as for flakes measuring ≥2.5 cm^2 from at least some of the cultural horizons.

Microscopic use-wear analyses should be performed on representative samples of tools, but particularly Paleoindian and, if recovered, pre-Clovis tools. Such analyses can provide basic technological information about human behavior (tool function, use-life, use history, probable contact materials, etc.) and other information about depositional contexts (postdepositional movement, high- or low-energy environments, etc.). Since this is the ultimate goal of any use-wear analysis, it is suggested

Figure 11.1. Large slump on cutbank at Big Eddy.

here that both low magnification (or the so-called "Keeley Approach") and high magnification (or the so-called "Semenov Approach") analyses be undertaken independently on the same tools. In so doing, mutually supportive results would permit stronger arguments about depositional integrity and tool functions.

Urgency of Future Archaeological Investigations

The Big Eddy site is in an especially precarious situation requiring immediate attention. It is undergoing extensive and rapid erosion due principally to power-generation releases from Stockton Dam. The extant portion of the site containing Paleoindian deposits is most threatened. Furthermore, some of the richest parts of the remaining Paleoindian deposits are probably now being impacted. Lateral bank erosion occurs by two processes: slumping of large blocks, and solution and disaggregation of soil particles. The first type of erosion is limited primarily to the upper half of the cutbank above the undercut high-water line (Figure 11.1), whereas the other type occurs along the lower half of the cutbank below the high-water line.

Comparison of a series of aerial photographs covering a 15-year period (1975–1990) revealed a minimum erosion rate of 0.58 m per year (Ziegler 1994). Supplemental information has recently been accumulated to demonstrate that the erosion has been accelerating. For example, the erosion rate during the past 11 years, a period beginning in 1986 and ending at the start of the 1997 investigations, was calculated as 0.82 m per year. For the Big Eddy site as a whole, this translates into the loss of about 330 m^3 of potential cultural deposits per year. Since August 1, 1997, additional data have been collected to illustrate that the erosion rate is even more acute (Table 11.1). As a result of seven visits to the Big Eddy site during the 14-month period ending on October 6, 1998, the pace of cutbank retreat is now

Table 11.1. Cutbank Erosion During a Recent 14-Month Interval.

	West to East					
Date	Station 3	Campfire	South Edge Block A	Wooden Post	South Edge 1986 Trench 3	Southwest Corner Block B
8/1/97	140	190	540	90	260	550
8/20/97[a]	74					
12/16/97	70	150		80		510
2/8/98	70	150		50		
6/7/98	47	110		0		500
8/22/98	47	100		0	200	460
10/6/98[a]	0	41	405	0	105	430
Total erosion	>140	149	135	>90	155	120

Note: Cell values are the shortest distance in centimeters from monitoring location to cutbank edge. A zero value indicates the cutbank eroded past the monitoring location and destroyed it.

[a]Following a large rain event.

calculated at an average rate of at least 1.32 m per year. This translates into losses of about 455 m^3 of potential cultural deposits per year. The most rapid slumpage and the largest slump blocks (2–3 m long by 60–100 cm thick) occur after large rains when the soil becomes saturated and much heavier. In contrast, the solution and disaggregation of soil particles from the lower half of the cutbank occurs when discharge is increased for generation of hydroelectric power. Monitoring of nails driven into the lower bank during the summer of 1997 revealed an average erosion rate of 1.3 cm/week (67.6 cm/year).

In addition to accelerated erosion, the site also has become increasingly vulnerable to vandalism due to recent media attention. Collectors have now started to dig into the cutbank, and evidence for an escalating amount of collecting has increased substantially.

SOME PARTING REMARKS

The text and the appendices in this report provide a very thorough description of the data obtained from the site. In places, we have attempted to go beyond the raw data and offer interpretations of past human behavior. These interpretations, perhaps viewed by some as "just-so stories," have invoked a number of assumptions. Whether one agrees or doesn't agree with these interpretations, we have offered them in an effort to put some life or action into the Big Eddy story. Aside from such interpretations, our work at the Big Eddy site has certainly demonstrated the importance of geoarchaeology. In CRM contexts, mandates to undertake such work, minimally at the survey level, vary from one state to the next. If anything, it is hoped that the Big Eddy site has demonstrated the importance of undertaking systematic geoarchaeological research in the floodplains of Missouri streams. We would suspect there are numerous sites similar to Big Eddy that remain buried in various river valleys throughout Missouri.

In light of the available data and previous discourse on the subject, one can find fault in our attempts to evaluate direct vs. indirect procurement of lithic resources, particularly since such questions may never be resolved. In fact, the primary and secondary authors of this chapter continue to disagree about the nature of Late Paleoindian chert-procurement strategies, viewing similar types of data in opposing ways. We have grappled with the issues and tried to derive mutually exclusive implications beyond those few offered by Meltzer (1989), but we have added nothing new on this interpretive dilemma. Nonetheless, we do not view this as an ef-

fort in futility, but rather as a rough beginning, an open-minded debate that might eventually lead toward answering questions that we conceive as particularly germane to anthropological issues. In addition, we have not merely assumed without proof that Paleoindians, but particularly Late Paleoindians, invariably procured their resources directly and then proceed to build models, for example, of Dalton mobility and territoriality. It seems most certain that assumptions of high mobility and direct procurement can be invoked for the period of initial colonization by Clovis or pre-Clovis foragers but not perhaps for Late Paleoindians (and perhaps even Middle Paleoindians) who had already completed the process of "settling in" to the region and various localities.

It is obvious from our own internal debate and those of many eminent scholars before us that questions of indirect vs. direct procurement may not be answered for post-Clovis Paleoindian and Early Archaic prehistory. This is particularly true in the absence of better controls over variation in time and space. Aspects of demography are especially crucial to examining such issues, as is the changing variety, density, and distribution of plant and animal resources on the late Pleistocene–early Holocene landscape. The density and rate of growth of the regional human population require considerable data on the numbers and extent of sites dating to fine-scale periods of time. This has proved elusive, even on a panregional level. Yet, the lower Sac River valley may provide one of the foremost laboratories for gaining insight into regional population dynamics during some of the earliest known periods of prehistory. This is due to the extensive numbers of exposed sites and paleolandforms eroding from cutbanks along the lower Sac River.

We also have loosely used the terms "component," "culture," or "people" in reference to a particular point type or style. The assumption of "one point [style]–one culture" has been much debated, and there is no easy answer to this question in the absence of extensive data from single-component sites spanning considerable time and space. Again, there is some disagreement among the authors in the application of such terms, but our disagreements are more of degree than kind. Nevertheless, recent investigations of some single-component or nearly single-component deposits in southwest Missouri suggest there may be some validity to the idea of one point–one culture. Indeed, the deeply buried, temporally discrete middle Late Archaic deposit at Big Eddy, which yielded only Williams points, appears to support it.

The assumption of one point–one culture has considerable implications for interpreting the pace and magnitude of cultural change, the scale and directionality of mobility, and the positioning of Big Eddy as a residential locus well within a territory or along a socioeconomic boundary. Again, more accurate and meaningful applications of such terms and such assumptions will require better controls over temporal and spatial variation, but we feel that continued conversations about such concepts and interpretations are essential for better understanding the meaning of future research data from the Big Eddy site and the lower Sac River region. In turn, potential new data from Big Eddy and the Sac River valley could shed considerable light on the validity of this assumption for this region during various episodes of prehistory.

Finally, the reader may have observed that in places we have related gross temporal changes in relative regional population density and, more specifically, the relative intensity of site use based in part on variation in the frequencies of different point types. We realize that one cannot invariably attribute increases in absolute numbers of projectiles points per type per unit time to absolute numbers of people. This realization is due mainly to our generally poor controls over projectile-point chronology, to the biased nature of our (mainly surface) survey data, to the ever changing character of point typologies, and to the paucity of information on site-formation processes, particularly as they relate to the production, use-life, and discard rates for projectile points. Still, it is felt that in some physical contexts and with better temporal controls, changes in absolute numbers generally do reflect changes in population density. Studies of the Big Eddy site and cutbanks along the Sac River, where the full sequence of late Pleistocene and Holocene landforms are exposed, provide a relatively unique opportunity to evaluate temporal variation in relative population density, as well as changes in settlement-subsistence strategies.

In summary, the Big Eddy site and the lower Sac River valley offer considerable research potential. As with any research endeavor of this type, more questions than answers have resulted. This is the natural course of scientific advancement or refinement. It is inevitable that more knowledge about the Big Eddy site and regional prehistory will ultimately lead to an even greater variety of more

detailed questions. One can only hope that Big Eddy does not erode away before some of these questions can be evaluated and new ones can be generated.

Despite the rapidly deteriorating condition of the site, the remaining deposits at Big Eddy offer a unique opportunity to investigate and answer questions regarding the earliest peopling of the midcontinent, as well as almost unlimited potential for studying cultural and ecological changes from the end of the Pleistocene epoch into the late Holocene. In fact, the Big Eddy site's potential for filling many voids in our knowledge of regional prehistory is unprecedented. This is due to the excellent preservation of features in at least the Paleoindian horizons, the essentially uninterrupted sequence of prehistoric site use, and the thick stratification within a sequence of rapidly aggrading alluvial units. There are perhaps other sites in the region with similar potential, but they have not yet been found or reported. It may be that the Big Eddy site could provide one of the best archaeological and paleoecological sequences in North America. As such, its significance cannot be underestimated.

APPENDIX 1

GLOSSARY

Alluvium (Alluvial): fine-grained sediment deposited by a stream or running water.

Archaeobotany: the recovery, analysis, and interpretation of plant remains from archaeological sites.

Argillaceous: a rock composed primarily of clay or containing an appreciable amount of clay.

Band: a small group of hunting and gathering peoples organized according to egalitarian principles; in cultural evolution, the simplest form of human society.

Botryoidal: having the form of a bunch of grapes

Brachiopod: an invertebrate bivalve animal (fossil) with two unequal shells.

Bryozoa: an invertebrate animal (fossil) with a branch-like structure.

Chipped-stone resources: an inclusive term used to refer to all rocks that exhibit conchoidal fracture which prehistoric Indians used to make chipped/flaked tools (includes chert, flint, jasper, quartzite, rhyolite, argillite, and other siliceous rocks).

Clast: an individual grain or fragment of a detrital sediment or sedimentary rock.

Component: a temporally distinctive cultural manifestation represented within an archaeological site; as used loosely here, component may refer to one or a few artifacts or a large groups of artifacts presumed to be related and distinctive based on stylistic attributes and/or stratigraphic occurrence; a component is assumed to represent the depositional remains of a group of people or a community that maintained a distinctive material culture and utilized the site continuously or intermittently.

Conchoidal: the shell-like (curved) surface produced by the fracture of brittle (chippable) rock or glass.

Conchoidal Fracture: the characteristic, cone-shaped fracture pattern or smoothly curved surfaces produced by certain siliceous rocks when broken as a result of pressure or percussive force.

Cortex: (cortical) the weathered outer rind of a chert nodule.

Crinoid: an invertebrate animal (fossil) with a long segmented stem (crinoidal: rock or nodule containing crinoid segments).

Debitage: flakes and other rock fragments that are by-products of chipped-stone tool manufacture.

Decortication: removal of cortical surfaces of chert nodules during the initial reduction stages of chipped stone tool manufacture.

Dolomite: a limestone rich in magnesium.

Ellipsoidal: a chert nodule having a flattened ellipsoidal shape

Epipedon: a diagnostic surface layer of soil, about 30 cm thick.

Facies: a distinctive group of sedimentary characteristics that differs from other groups within a stratigraphic unit (especially laterally distinct).

Flotation: a technique for recovering fine debris by immersing excavated sediments; theoretically, lighter plant tissues float to the surface (the light fraction) whereas heavier materials do not (the heavy fraction).

Fossiliferous: containing organic (fossil) remains.

Geoarchaeology: the study and interpretation of archaeological sites and archaeological remains with a thorough understanding of geological and geomorphological processes.

Geomorphology: the study of the classification, description, nature, origin, and development of present landforms and their relationships to underlying structures.

Graveliferous: a layer or substratum containing large quantities of alluvial gravel.

Holocene: the most recent epoch of the Quaternary period when modern climatic conditions and environments were established (approximates the last 10,000 years).

Illuvial: the accumulation of suspended material (e.g., clay) in a lower soil horizon from an upper horizon.

Krotovina: an irregular tubular or tunnel-like structure in soil, made by a burrowing animal and subsequently filled-in.

Laminae: the smallest recognizable unit layer or original deposition in a sediment, differing from other layers in color, composition, or particle size.

Lithic: refers to any rock or stone; in archeology it usually refers to chippable rocks or rocks exhibiting conchoidal fracture.

Lithology: the physical character of a rock or rock formation.

Lithostratigraphy: preliminary stratigraphy based only on the physical and pedographic features of sediments or rocks.

Midden: a deposit composed largely of human refuse.

Occupation Surface: a buried surface or paleosurface that was once inhabited or utilized by humans.

Oolite: (oolitic) a nonfossiliferous spherical or ellipsoidal body 0.25–2.00 mm in diameter; used here to refer to such objects in chert nodules.

Paleoecology: the study of past assemblages of living organisms and their physical milieus.

Paleogeomorphic: pertaining to the recognition of ancient erosion surfaces and with the study of ancient topographic features.

Paleosol: a buried soil.

Pedogenesis: the process of soil formation.

Pedostratigraphic: the stratigraphic study of soils.

Phase: an archaeological culture restricted in space and appearing within a relatively brief interval of time.

Phytolith: tiny silica particles (plant opal) that are contained within plants, that are relatively indestructible and may remain in soils long after other tissues have decomposed, and that are often taxonomically distinct in structural form.

Pleistocene: the earliest epoch of the Quaternary period, often called the Ice Age; a time of repeated glacial advances and retreats.

Point bar: one of a series of low, arcuate ridges of sand and gravel developed on the inside of a growing meander, accompanying the migration of the channel toward the outer bank.

Quartzoze: granular quartz or quartz deposits with a sugar-like texture that inhibits conchoidal fracture.

Redoximorphic: a soil feature that is formed by the reduction and oxidation of iron and magnesium compounds in seasonally saturated soils (e.g., a root cast).

Residuum: soil formed in place by the disintegration of rocks and subsequent weathering of minerals.

Sponge spicule: the needle-shaped fossil remains of a sponge.

Striking Platform: the portion of an artifact's surface to which force (pressure or percussion) is applied during the detachment of flakes.

Thalweg: the deepest portion of a stream channel.

APPENDIX 2

FAUNAL ANALYSIS

Bonnie W. Styles

The 1997 excavations at the Big Eddy site, 23CE426, by the Center for Archaeological Research at Southwest Missouri State Univeristy yielded few faunal remains. Five samples were submitted to the Illinois State Museum for faunal identification. The remains were identified and described in the Illinois State Museum's Osteology Laboratory. Preservation of fauna at the site is extremely poor, and only a few small fragments are present in these samples. Most of the fragments are extremely friable and degraded and are embedded in sediment matrix. Given the fragile nature of the specimens and the extreme unlikelihood of precise taxonomic identification, they were not removed from the matrix. They were examined under a dissecting microscope and described. The following attributes are recorded: Provenience (site, test unit, level, and depth below surface), taxon, element, body size, burning, weathering, number identical for all attributes, and comments (e.g., condition and size of fragments).

Test Unit 5, Level 24

This sample included 6 fragments of possible animal bone embedded in sediment matrix. The remains are extremely degraded and do not reveal obvious boney structure. The pieces were examined under a dissecting microscope by the author, Dr. Jeffrey Saunders, Dr. Terrance Martin, Karli White, and Mona Colburn, all experts at faunal identification. The consensus is that the remains are either degraded fragments of calcined bone or degraded rock or mineral. All are weathered and extremely friable. One fragment exhibits small polished areas and several have black streaks running through them. Testing of the two largest specimens with dilute (10%) hydrochloric acid did not result in effervescence, suggesting that they are not limestone. Careful removal of sediment around the largest fragment (17 mm x 2 mm) revealed an outer cortex which may indeed suggest that the piece is bone. Another small fragment in the same clump of matrix also appears to have some characteristics of bone. The clumps of matrix contain approximately six pieces of this material, which has been tentatively identified as bone from indeterminate medium to large size mammal. All are calcined, weathered, and extremely friable.

Test Unit 5, Level 25

This sample included about 20 fragments of bone from indeterminate medium to large size mammal. Most of the fragments are small and embedded in matrix. The best preserved piece is 6 mm by 4 mm. The largest fragment is 8 mm by 5 mm and is embedded in a clump of sediment matrix. All of the fragments are calcined, weathered, and friable.

Test Unit 5, Level 25

This sample included 10 tiny fragments of bone from indeterminate medium to large size mammal. Most of the fragments are about 3 mm by 2 mm and are embedded in small clumps of sediment matrix. All are calcined, weathered, and friable.

Test Unit 25, Level 35

This sample contained one small (3 mm x 2 mm) fragment of bone from an indeterminate

medium to large size mammal. The specimen is calcined, weathered, and degraded. Not much boney structure is evident.

Test Unit 35, Level 31

The sample was thought to contain a few fragments of bone. However, examination under the microscope revealed only thin bands of sand in clumps of sediment matrix.

Conclusion

None of the remains could be identified below the level of class or to specific body part. In most instances specimens are so degraded that it was difficult to determine if they were indeed bone. Based on size and a visual assessment of overall bone density, all appear to be from indeterminate medium to large size mammal.

APPENDIX 3

CORE DESCRIPTIONS

Note: Horizons marked with an asterisk indicate a welded soil.

Core 2

Location: 554.89 E 460.19 W
Landscape Position: T1a terrace, on local high point
Altitude: 236.96 m asl

Depth (m)	Horizon	Description
0.00–0.12	Ap1	very dark to dark grayish brown (10YR 3.5/2) silt loam; weak medium subangular blocky parting to moderate fine subangular blocky; friable; noneffervescent; clear boundary.
0.12–0.33	Ap2	very dark grayish brown (10YR 3/2) silt loam; moderate medium parting to fine angular blocky and moderate fine angular blocky, with continuous thin very dark grayish brown (10YR 3/2) clay films; friable; noneffervescent; clear boundary.
0.33–0.61	Bt1	dark brown (10YR 3.5/3) heavy silt loam; moderate medium parting to fine angular blocky and subangular blocky, with continuous thin 10YR 3/2) clay films on ped faces and few thin very dark grayish brown (10YR 3/2) clay films lining pores, and few discontinuous thin dark grayish brown (10YR 4/2) silt coatings lining pores; firm; noneffervescent; clear boundary.
0.61–0.75	Bt2	dark brown to brown (10YR 4/3) light silty clay loam; moderate coarse parting to medium subangular blocky tending to prismatic, with continuous thin 10YR 3/2) clay films on ped faces and few thin very dark grayish brown (10YR 3/2) clay films lining pores, and few discontinuous thin dark grayish brown (10YR 4/2) silt coatings lining pores; firm; noneffervescent; few very fine ferromanganese dots and concretions; clear boundary.
0.75–0.93	2Ab (Bt3)*	very dark to dark grayish brown (10YR 3.5/2) light silty clay loam; moderate medium parting to fine prismatic and moderate fine subangular blocky, with continuous thin very dark grayish brown (10YR 3/2) clay films on ped faces and lining pores, and many discontinuous thin light brownish gray (10YR 6/2) silt coatings on ped faces and lining pores; firm; noneffervescent; few very fine ferromanganese dots and concretions; clear boundary.
0.93–1.14	2Ab	very dark grayish brown (10YR 3/2) silty clay loam; moderate medium prismatic parting to moderate medium and fine angular blocky, with continuous thin very dark brown (10YR 2/2) clay films on ped faces and many discontinuous thin light brownish gray (10YR 6/2) silt coatings on ped faces and interiors; very firm; noneffervescent; few fine ferromanganese concretions; gradual boundary.
1.14–1.33	2Btb1	dark brown (10YR 3.5/3) silty clay loam; moderate medium and coarse prismatic parting to moderate medium angular blocky, with continuous thin very dark brown (10YR 2/2) clay films on ped faces, few thin very dark brown (10YR 2/2) clay films lining pores, and many discontinuous thin light brownish gray (10YR 6/2) silt coatings on ped faces and interiors; very firm; noneffervescent; many fine ferromanganese concretions; gradual boundary.

Depth (m)	Horizon	Description
1.33–1.61	2Btb2	dark yellowish brown (10YR 3/4) silty clay loam; moderate coarse prismatic, with continuous thin very dark brown (10YR 2/2) clay films on ped faces, common continuous thin very dark brown (10YR 2/2) clay films lining pores, and common discontinuous thin light brownish gray (10YR 6/2) silt coatings on ped faces and interiors; very firm; noneffervescent; many fine ferromanganese concretions; gradual boundary.
1.61–2.10	2Btb3	dark yellowish brown (10YR 3/4) silty clay loam; moderate coarse prismatic, with continuous thin very dark grayish brown (10YR 3/2) clay films on ped faces and lining pores, and few discontinuous thin light brownish gray (10YR 6/2) silt coatings on ped faces and interiors and lining pores; very firm; noneffervescent; common decreasing downward to ferromanganese concretions; gradual to clear boundary.
2.10–2.49	2Btb4	dark yellowish brown (10YR 3/4) light silty clay loam; strong coarse prismatic parting to moderate coarse angular blocky, with continuous thin very dark grayish brown (10YR 3/2) clay films on ped faces and lining pores, and common discontinuous thin to moderately thick light brownish gray (10YR 6/2) and pale brown (10YR 6/3) silt coatings on ped faces and lining pores; firm; noneffervescent; gradual boundary.
2.49–2.79	2Btb5	dark yellowish brown (10YR 3.5/4) light silty clay loam; few faint coarse dark grayish brown (10YR 4/2) mottles on ped faces; strong coarse prismatic, with continuous thin very dark grayish brown (10YR 3/2) clay films on ped faces and lining pores, and few to common discontinuous thin to moderately thick light brownish gray (10YR 6/2) and pale brown (10YR 6/3) silt coatings on ped faces and lining pores; firm; noneffervescent; clear boundary.
2.79–3.24	3Ab (2Btb6)*	dark brown (10YR 3/3) grading downward to very dark grayish brown (10YR 3/2) silty clay loam; weak coarse prismatic parting to moderate and fine medium subangular blocky and angular blocky, with many discontinuous thin very dark brown to very dark grayish brown (10YR 2.5/2) clay films on ped faces and common continuous thin very dark brown to very dark grayish brown (10YR 2.5/2) clay films lining pores, and many discontinuous thin light brownish gray (10YR 6/2) and pale brown (10YR 6/3) silt coatings on ped faces; firm; noneffervescent; one very fine piece of ochre; gradual boundary.
3.24–3.51	3Btb1	dark brown (10YR 3/3) silty clay loam, with some sand; common medium and coarse dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) oxide depletion zones with dark yellowish brown (10YR 3/6) oxidized halos; moderate coarse parting to medium subangular blocky and angular blocky, with many discontinuous thin very dark brown to very dark grayish brown (10YR 2.5/2) clay films on ped faces and lining pores; firm; noneffervescent; common medium ferromanganese stains; flake at 3.46 m; chert pebble at 3.48 m; clear boundary.
3.51– 3.86	3Btb2	dark yellowish brown (10YR 3/4) clay loam, with very few fine pebbles and granules; common medium dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) oxide depletion zones with dark yellowish brown (10YR 3/6) oxidized halos; weak coarse subangular blocky, with very few discontinuous thin very dark grayish brown (10YR 3/2) clay films lining pores; firm; noneffervescent; chert pebbles at 3.54 and 3.66 m; clear to abrupt boundary.
3.86–4.00	4BCb1	dark yellowish brown (10YR 3/4) clast supported chert pebble gravel in a clay loam matrix; very weak coarse subangular blocky over single thin bed; firm; noneffervescent; clear to abrupt boundary.
4.00–4.35	5BCb2	dark yellowish brown (10YR 3.5/4) light clay loam to loam, with few pebble gravels; common fine dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) oxide depletion zones; very weak coarse subangular blocky over very weakly expressed stratification; firm; noneffervescent; common fine pores; pebbles at 4.19, 4.20, and 4.21 m; abrupt boundary.
4.35–4.58	5C1	dark yellowish brown to strong brown (10YR – 7.5YR 3.5/6) pebbly sandy loam, with some clay, with common fine pebble gravels up to 3 cm diameter; few horizontal dark grayish brown (10YR 4/2) oxide depletion zones mimicking bedding; stratified, very weakly downward to moderately expressed; firm to friable; noneffervescent; abrupt boundary.
4.58–4.64+	6C2	dark brown (10YR 3/3) clast supported gravel with clay loam matrix; some clasts with thin to moderately thick clay and clay loam films; friable; noneffervescent; base of core.

Core 5

Location: 541.79 E, 649.25 N
Landscape Position: T1a terrace, on local high point
Altitude: 236.23 m asl

Depth (m)	Horizon	Description
0.00–0.15	Ap	dark brown (10YR 4/3 to 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; clear boundary.
0.15–0.48	E	brown (10YR 5/3) silt loam, pale brown to brown (10YR 6/3 to 5/3) dry; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.48–0.75	E/Bt1	50% brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry, 50% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.75–1.40	E/Bt2	75% brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry, 25% dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint and distinct yellowish brown (10YR 5/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common patchy dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
1.40–1.90	2Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores, and common pale brown (10YR 6/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.90–2.50	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
2.50–3.20	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
3.20–3.50	2Btb3	dark yellowish brown (10YR 4/4) silty clay loam, Yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine soft ferromanganese accumulations; gradual boundary.
3.30–3.90	3Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; few very fine soft ferromanganese accumulations; gradual boundary.
3.90–4.90	3Btb	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with few patchy very pale brown (10YR 7/3) silt coating on ped faces; friable; noneffervescent; common fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.90–5.30	3BCb	dark brown (7.5YR 4/4) clay loam grading downward to sandy loam, brown (7.5YR 5/4) moist; many fine prominent strong brown (7.5YR 5/6 and 4/6) and few fine prominent yellowish red (5YR 4/6) mottles; common gray (10YR 5/1) reduction zones along pores; very weak fine subangular blocky; firm; noneffervescent; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary.
5.30–5.35	4C	Chert gravel; single grain; loose.

Core 6

Location: 548.74 E, 612.79 N
Landscape Position: T1a terrace
Altitude: 235.49 m asl

Depth (m)	Horizon	Description
0.00–0.10	Ap	dark brown (10YR 3/3) heavy silt loam, dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.10–0. 25	BA	dark brown (10YR 4/3) light silty clay loam, yellowish brown (10YR 4/4) to dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.25–0.45	Bt1	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with few patchy dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.45–0.89	Bt2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.89–1.16	2Ab (Bt3)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.16–1.95	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coating on ped faces; friable; noneffervescent; gradual boundary.
1.95–2.59	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine distinct yellowish brown (10YR 5/6) and yellowish red (5YR 4/6) mottles and common fine distinct strong brown (7.5YR 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores; friable; noneffervescent; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
2.59–3.07	2Btb3	dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; few fine distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few patchy brown (7.5YR 5/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay flows lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.07–3.86	2Btb4	dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; few fine distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; weak fine prismatic parting to weak fine subangular blocky, with few patchy brown (7.5YR 5/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay films lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.86–4.03	2BCb	dark brown (7.5YR 4/4) clay loam grading downward to fine sandy loam, strong brown (7.5YR 4/6) dry; common fine distinct strong brown (7.5YR 5/8) and few fine prominent yellowish red (5YR 5/8) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; common subrounded chert and limestone pebbles at 395-403 cm; abrupt boundary.
4.03–4.35	3C	Sandy fine gravel; single grain; loose.

Core 7

Location: 556.89 E, 573.87 N
Landscape Position: T1a terrace
Altitude: 235.56 m asl

Depth (m)	Horizon	Description
0.00–0.10	Ap	dark brown (10YR 4/3 to 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; clear boundary.
0.10–0.22	BA	dark brown (10YR 4/3) light silty clay loam, yellowish brown (10YR 4/4) to dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.22–0.56	E/Bt1	50% brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry, 50% dark yellowish brown (10YR 4/4) moist light silty clay loam yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.56–0.71	E/Bt2	75% brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry, 25% dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.71–1.10	2Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and common pale brown (10YR 6/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.10–1.50	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct dark brown (7.5YR 4/4) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores; few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.50–2.20	2Btb2	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and common thick dark brown (10YR 4/3) clay films lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
2.20–3.30	2Btb3	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; few gray (10YR 5/1) reduction zones along pores and root channels; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (7.5YR 4/4) clay films on ped faces and common thick dark brown (10YR 4/3) clay films lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; few very fine soft ferromanganese accumulations; gradual boundary.
3.30–3.90	2Btb4	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky; friable; noneffervescent; few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and common thick dark brown (10YR 4/3) clay films lining pores; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.90–4.15	2Btb5	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; common gray (10YR 5/1) reduction zones along pores and root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few thick dark brown (10YR 4/3) clay films lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.

Depth (m)	Horizon	Description
4.15–5.40	2BCb	dark brown (7.5YR 4/4) clay loam grading downward to sandy clay loam, brown (7.5YR 5/4) dry; many fine distinct gray (10YR 5/1) and fine prominent strong brown (7.5YR 5/6 and 4/6) and yellowish red (5YR 4/6) mottles; very weak fine subangular blocky; firm; noneffervescent; many very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary.
5.40–5.80	3C	Chert fine gravel; single grain; loose.

Core 8

Location: 564.27 E 537.41 N
Landscape Position: T1a terrace
Altitude: 235.66 m asl

Depth (m)	Horizon	Description
0.00–0.08	Ap	dark brown (10YR 3/3) silt loam; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; clear boundary.
0.08–0.17	BA	dark brown to brown (10YR 4/3) silt loam; common fine faint yellowish brown (10YR 5/4) mottles; weak fine to medium subangular blocky; friable; noneffervescent; clear boundary.
0.17–0.36	Bt1	dark brown to brown (10YR 4/3) silt loam; moderate medium to coarse subangular blocky, with common almost continuous thin dark brown (10YR 3/3) clay coats on ped faces and lining pores; firm; noneffervescent; gradual boundary.
0.36–0.76	Bt2	dark brown to brown (10YR 4/3) silt loam; moderate medium to coarse subangular blocky parting to very fine to fine subangular blocky, with common almost continuous thin very dark grayish brown to dark brown (10YR 3/2.5) clay coats on ped faces and lining pores; firm; noneffervescent; clear boundary.
0.76–0.83	2Ab (Bt3)*	dark brown (10YR 3/3) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and common pale brown (10YR 6/3) silt coatings on ped faces; firm; noneffervescent; gradual boundary.
0.83–0.96	2Btb1	dark brown (10YR 4/3) silty clay loam; common fine distinct dark brown to brown (7.5YR 4/4) mottles; moderate medium prismatic parting to moderate coarse subangular and angular blocky, with many continuous dark brown (10YR 3/3) and dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and common thin light brownish gray (10YR 6/2) silt coatings on ped faces; firm; noneffervescent; gradual boundary.
0.96–2.03	2Btb2	dark brown (10YR 4/3) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate coarse subangular to angular blocky, with many continuous thin dark brown (10YR 3/3) clay films on ped faces, common thin to thick dark brown (10YR 3/3) clay films lining pores and common thin very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
2.03+	2Btb3	dark brown (7.5YR 4/4) light silty clay loam; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; few gray (10YR 5/1) reduction zones along pores and root channels; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (7.5YR 4/4) clay films on ped faces and common thick dark brown (10YR 4/3) clay films lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; few very fine soft ferromanganese accumulations; gradual boundary.

Core 9

Location: 569.01 E, 515.03 N
Landscape Position: T1a terrace
Altitude: 235.6 m asl

Depth (m)	Horizon	Description
0.00–0.10	Ap	dark brown (10YR 3/3) silt loam, dark brown (10YR 4/3) dry; weak fine subangular blocky; friable; noneffervescent; common fine faint yellowish brown (10YR 5/4) mottles; gradual boundary.
0.10–0.20	BA	dark brown (10YR 4/3) light silty clay loam, yellowish brown (10YR 4/4) to dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.20–0.43	Bt1	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.43–0.54	Bt2	dark yellowish brown (10YR 4/4) moist silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.54–0.80	2Ab (Bt3)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.80–1.20	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.20–1.82	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine distinct yellowish brown (10YR 5/6) and yellowish red (5YR 4/6) mottles and common fine distinct strong brown (7.5YR 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores; friable; noneffervescent; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
1.82–2.27	2Btb3	dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; few fine distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces and few dark brown (10YR 4/3) clay films lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
2.27–3.22	2Btb4	dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; few fine distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous brown (7.5YR 5/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay films lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.22–3.90	2Btb5	dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; few fine distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous brown (7.5YR 5/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay films lining pores; friable; noneffervescent; many very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.

Depth (m)	Horizon	Description
3.90–4.20	2BCb	dark brown (7.5YR 4/4) clay loam grading downward to fine sandy loam, strong brown (7.5YR 4/6) dry; common fine distinct strong brown (7.5YR 5/8) and few fine prominent yellowish red (5YR 5/8) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; common subrounded chert and limestone pebbles at 415-420 cm; abrupt boundary.
4.20+	3C	Sandy fine pebble gravel; single grain; loose.

Core 10

Location: 586.16 E, 498.03 N
Landscape Position: T1a terrace in a swale that marks the position of a flood chute
Altitude: 235.39 m asl

Depth (m)	Horizon	Description
0.00–0.15	Ap	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine and very fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 4/6) mottles; weak fine subangular block; friable; noneffervescent; clear boundary.
0.15–0.25	A	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine and very fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 4/6) mottles; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.25–0.75	E/Bt	60% brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry, 40% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) light dry; few fine and very fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 4/6) mottles; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.75–1.20	Bt/E	40% brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry, 60% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) light dry; few fine and very fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 4/6) mottles; weak fine prismatic parting to weak fine subangular blocky; friable; noneffervescent; few discontinuous dark brown (10YR 4/3) clay films on ped faces; gradual boundary.
1.20–1.80	Bt1	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; few fine distinct strong brown (7.5YR 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.80–2.30	Bt2	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; few fine distinct strong brown (7.5YR 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
2.30–2.80	Bt3	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; few fine distinct strong brown (7.5YR 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; clear boundary.
2.80–3.20	2Ab (Bt)*	dark brown (7.5YR 4/3) silty clay loam, brown (10YR 5/3) dry; few fine distinct strong brown (7.5YR 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.

Depth (m)	Horizon	Description
3.20–3.60	2Btb1	dark brown (7.5YR 3/4) silty clay loam, dark brown (7.5YR 4/4) to dark yellowish brown (10YR 4/4) dry; few fine distinct strong brown (7.5YR 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces, common prominent very dark grayish brown (10YR 3/2) clay films lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.60–3.95	2Bt2b2	dark brown (7.5YR 4/4) light silty clay loam, strong brown (7.5YR 4/6) dry; few gray (10YR 5/1) reduction zones along root channels; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces, common prominent very dark grayish brown (10YR 3/2) clay films lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.95–4.40	2BCb	dark brown (7.5YR 4/4) clay loam grading downward to loam, strong brown (7.5YR 4/6) dry; common fine distinct strong brown (7.5YR 5/8) mottles; common gray (10YR 5/1) reduction zones along root channels and pores; very weak fine prismatic parting to very weak fine subangular blocky; firm; noneffervescent; many very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations.

Core 11

Location: 642.99 E, 510.61 N
Landscape Position: T1a terrace
Altitude: 235.86 m asl

Depth (m)	Horizon	Description
0.00–0.15	Ap	dark brown (10YR 4/3 to 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; clear boundary.
0.15–0.27	A	dark brown (10YR 3/3) silt loam, dark brown (10YR 4/3) dry; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; gradual boundary.
0.27–0.45	E	brown (10YR 5/3) silt loam, pale brown to very pale brown (10YR 6/3 to 7/3) dry; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.45–0.65	E/Bt	50% pale brown (10YR 6/3) silt loam, very pale brown (10YR 7/3) dry, 50% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.65–0.95	2Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and common pale brown (10YR 6/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.95–1.10	2Btb	dark brown (7.5YR 4/4) silty clay loam, strong brown (10YR 5/6) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.10–1.30	3Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; weak fine prismatic parting to weak fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.

Depth (m)	Horizon	Description
1.30–1.95	3Bt1b	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6), brown (7.5YR 4/4), and strong brown (7.5YR 4/6) and few very fine prominent yellowish red (5YR 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; clear boundary.
1.95–2.75	3Bt2b	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6), brown (7.5YR 4/4), and strong brown (7.5YR 4/6) and few very fine prominent yellowish red (5YR 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few dark brown (10YR 4/3) clay films lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; abrupt boundary.
2.75–3.15	4Ab (Bt)*	dark brown (7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) dry; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
2.75–3.15	4Bt1b	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; common gray (10YR 5/1) reduction zones along pores and root channels; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (7.5YR 4/4) clay films on ped faces, few thick dark brown (10YRYR 4/3) clay films lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.15–3.60	4Bt2b	dark brown (7.5YR 4/4) clay loam with common granules, strong brown (7.5YR 4/6) dry; common fine distinct yellowish brown (10YR 5/6) mottles; common gray (10YR 5/1) reduction zones along pores and root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few thick dark brown (10YRYR 4/3) clay flows lining pores; firm; noneffervescent; many very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.30–4.52	2BCb	dark brown (7.5YR 4/4) loam coarsening downward to fine sandy loam, strong brown (7.5YR 4/6) dry; few fine distinct yellowish brown (10YR 5/6) mottles; few gray (10YR 5/1) reduction zones along pores and root channels; very weak fine subangular blocky; friable noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.52–4.58+	2C	strong brown (7.5YR 4/6) medium and coarse sand; single grain; loose.

Core 12

Location:	623.07 E, 507.47 N
Landscape Position:	T1a terrace
Altitude:	235.84 m asl

Depth (m)	Horizon	Description
0.00–0.15	Ap	dark brown (10YR 4/3 to 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; clear boundary.
0.15–0.25	A	dark brown (10YR 3/3) dark brown (10YR 4/3) silt loam, dry; weak fine subangular blocky parting to moderate fine and medium granular; friable; noneffervescent; gradual boundary.
0.25–0.55	E	brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.55–0.77	E/Bt	50% brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry, 50% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.

Depth (m)	Horizon	Description
0.77–1.20	2Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and common pale brown (10YR 6/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.20–1.90	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.90–2.30	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; few very fine soft ferromanganese accumulations; gradual boundary.
2.30–3.20	2Btb3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct dark brown (7.5YR 4/4) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; common very fine soft ferromanganese accumulations; gradual boundary.
3.20–3.80	2Btb4	dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate fine prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few dark brown (10YRYR 4/3) clay flows lining pores; friable; noneffervescent; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.80–4.30	2Btb5	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few dark brown (10YR 4/3) clay flows lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.30–4.80	2BCb	dark brown (7.5YR 4/4) clay loam, strong brown (7.5YR 4/6) dry; common fine distinct strong brown (7.5YR 5/8) and few fine prominent yellowish red (5YR 5/8) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky; firm; noneffervescent; abundant very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary.
4.80–4.90+	3C	Chert pebble gravel; single grain; loose.

Core 14

Location: 542.19 E, 478.69 N
Landscape Position: T1a terrace
Altitude: 235.61 m asl

Depth (m)	Horizon	Description
0.00–0.25	Bt1	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.25–0.53	Bt2	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.53–0.84	2Ab	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.84–1,12	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.12–1.65	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct dark brown (7.5YR 4/3 and 4/4) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common nearly continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.65–2.46	2Btb3	dark brown (7.5YR 4/3) dark brown (7.5YR 4/4) silty clay loam, dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous brown (7.5YR 5/4) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; friable; noneffervescent; clear boundary.
2.46–2.79	3Ab (2btb4)*	dark brown (7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) dry; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (7.5YR 4/4) clay films on ped faces and lining pores; friable; noneffervescent; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
2.79–3.25	3Btb1	dark brown (7.5YR 4/4) silty clay loam, with lenses of chert and limestone pebbles at 313-325 cm; strong brown (7.5YR 4/6) dry; few fine faint grayish brown (2.5Y 5/2) mottles; weak fine prismatic parting to weak fine subangular blocky, with common discontinuous dark brown (7.5YR 4/4) clay films on ped faces and lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.25–3.50	3Btb2	dark brown (7.5YR 4/4) clay loam, strong brown (7.5YR 4/6) dry; common fine distinct grayish brown (2.5Y 5/2) mottles; weak fine prismatic parting to weak fine subangular blocky; common discontinuous dark brown (7.5YR 4/4) clay films on ped faces and lining pores; firm; noneffervescent; many very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.50–3.68	3BCb	dark brown (7.5YR 4/4) coarse clay loam grading downward to sandy clay loam, strong brown (7.5YR 4/6) dry; common fine distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) mottles; weak fine prismatic parting to weak fine subangular blocky; firm; noneffervescent; many very fine and fine ferromanganese discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary.
3.68–3.73	4C	Sandy fine gravel; single grain; loose.

Note: Surface soil is welded onto the 2Ab soil. The 2Ab soil is welded onto the 3Ab soil. Upper 25 cm was stripped off with heavy machinery in the area of this core. A large chert flake was recovered at a depth of 261 cm (3Ab horizon).

Core 15

Location: 528.13 E, 472.85 N
Landscape Position: T1a terrace
Altitude: 235.77 m asl

Depth (m)	Horizon	Description
0.00–0.20	Bt1	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
0.20–0.43	Bt2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
0.43–0.63	Bt3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; clear boundary.
0.63–0.96	2Ab (Bt4)	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
0.96–1.24	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
1.24–2.28	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
2.28–3.30	2Btb3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; few very fine soft ferromanganese accumulations; noncalcareous; gradual boundary.
3.30–3.68	2Btb4	dark brown (7.5YR 4/4) silty clay loam, dry strong brown (7.5YR 4/6); common fine distinct strong brown (7.5YR 5/8) mottles; few gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous brown (7.5YR 5/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay films lining pores; friable; noncalcareous; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.68–4.45	2Btb5	dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; common fine distinct strong brown (7.5YR 5/8) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous brown (7.5YR 5/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay films lining pores; friable; noncalcareous; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.

Depth (m)	Horizon	Description
4.45–5.20	2BCb	dark brown (7.5YR 4/4) clay loam, strong brown (7.5YR 4/6) silty dry; common fine distinct strong brown (7.5YR 5/8) and few fine prominent yellowish red (5YR 5/8) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces and few dark brown (10YR 4/3) clay films lining pores; friable; noncalcareous; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; few subrounded limestone pebbles at 508-509 cm; gradual boundary.
5.20–5.96	2C1	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; common fine and medium distinct yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles and common fine prominent strong brown (7.5YR 4/6) mottles; massive; firm; noncalcareous; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
5.96–6.47	2C2	50% dark brown (7.5YR 4/4) clay loam, strong brown (7.5YR 4/6) dry; 50% grayish brown (2.5Y 5/2) light brownish gray (2.5Y 6/2), dry; common fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 4/6 and 5/8) mottles; massive; firm; noncalcareous; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
6.47–6.90	2C2	50% dark brown (7.5YR 4/4) clay loam grading downward to fine sandy loam, strong brown (7.5YR 4/6) dry; 50% grayish brown (2.5Y 5/2), light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 4/6 and 5/8) mottles; massive; firm; noncalcareous; weakly expressed bedding; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; common chert and limestone pebbles in the lower 10.

Note: Surface soil is welded onto the 2Ab soil. Upper 25 cm was stripped off with heavy machinery in the area of this core.

Core 16

Location: 516.74 E, 465.97 N
Landscape Position: T1a terrace
Altitude: 235.83 m asl

Depth (m)	Horizon	Description
0.00–0.25	AE	dark brown (10YR 4/3 to 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky parting to moderate fine granular; friable; noneffervescent; gradual boundary.
0.25–0.45	E/Bt1	50% brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry, 50% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.45–0.80	E/Bt2	60% brown (10YR 5/3), very pale brown (10YR 7/3) silt loam dry, 40% dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; noneffervescent; gradual boundary.
0.80–1.10	2Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.10–1.65	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.65–2.20	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.

Depth (m)	Horizon	Description
2.20–3.20	2Btb3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; few very fine and fine soft ferromanganese accumulations; noneffervescent; gradual boundary.
3.20–4.00	2Btb4	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate fine prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; friable; noneffervescent; gradual boundary.
4.00–4.40	2Btb5	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/6 and 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few dark brown (7.5YR 4/4) clay films lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.40–4.90	2BCb	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; many fine and medium distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; very weak fine subangular blocky; friable; noneffervescent; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.90–5.20	2C	dark brown (7.5YR 4/4) light silty clay loam interbedded with clay loam, loam, and fine sandy loam, brown (7.5YR 5/4) dry; many fine and medium distinct yellowish brown (10YR 5/6), strong brown (7.5YR 5/8 and 4/6), and grayish brown (2.5Y 5/2) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; massive; firm; noneffervescent; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
5.20–5.60	2Cg	grayish brown (2.5Y 5/2) light silty clay loam interbedded with clay loam, loam, and fine sandy loam, Light brownish gray (2.5Y 6/2) dry; many fine prominent dark brown (7.5YR 4/4), strong brown (7.5YR 4/6 and 5/6) and yellowish red (5YR 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; massive; firm; noneffervescent; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary.
5.60–6.40+	3C	yellowish red (5YR 4/6) medium sand grading downward to chert pebble gravel; single grain; loose; noneffervescent.

Note: The upper 25 cm was stripped off with heavy machinery in the area of this core.

Core 17

Location: 508.67 E, 460.43 N
Landscape Position: T1a terrace
Altitude: 235.89 m asl

Depth (m)	Horizon	Description
0.00–0.20	BA	dark brown (10YR 4/3) light silty clay loam, yellowish brown (10YR 4/4) to dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky; friable; noneffervescent; gradual boundary.
0.20–0.48	Bt1	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.

Depth (m)	Horizon	Description
0.48–0.90	Bt2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
0.90–1.18	2Ab (Bt)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.18–1.80	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
1.80–2.40	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; gradual boundary.
2.40–3.30	2Btb3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common coarse discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noneffervescent; few very fine soft ferromanganese accumulations; gradual boundary.
3.30–3.90	2Btb4	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate fine prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few dark brown (10YRYR 4/3) clay films lining pores; friable; noneffervescent; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.90–4.20	2Btb5	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces and few dark brown (10YR 4/3) clay films lining pores; friable; noneffervescent; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.20–4.50	2BCb	50% dark brown (7.5YR 4/4) light silty clay loam, strong brown (7.5YR 4/6) dry; 50% grayish brown (2.5Y 5/2), light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 4/6 and 5/8) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; very weak fine subangular blocky; friable; noneffervescent; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.50–5.05	2C	50% dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 4/6) dry; 50% grayish brown (2.5Y 5/2), light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 4/6 and 5/8) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; massive; firm; noneffervescent; abundant fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
5.05–5.45	2Cg	grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 4/6 and 5/8) and yellowish red (5YR 4/6 and 5/8) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; massive; very firm; noneffervescent; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary.
5.45–5.50+	3C	Chert pebble gravel; single grain; loose.

Note: Surface soil is welded onto the 2Ab soil. The upper 25 cm was stripped off with heavy machinery in the area of this core. Flake at 102 cm below the surface.

Core 18

Location: 499.35 E, 455.74 N
Landscape Position: T1a terrace
Altitude: 235.96 m asl

Depth (m)	Horizon	Description
0.00–0.30	AB	dark brown (10YR 3/3) silt loam, dark brown (10YR 4/3) dry; common fine faint yellowish brown (10YR 5/4) mottles; gradual weak fine subangular blocky; friable; noncalcareous; boundary.
0.30–0.63	Bt/E1	70% dark brown (10YR 4/3) light silty clay loam, yellowish brown (10YR 4/4) to dark brown (10YR 4/3) dry, 30% pale brown (10YR 6/3), very pale brown (10YR 7/3) silt loam dry; weak fine prismatic parting to weak fine subangular blocky; friable; noncalcareous; gradual boundary.
0.63–1.08	Bt/E2	50% dark brown (10YR 4/3) light silty clay loam, yellowish brown (10YR 4/4) to dark brown (10YR 4/3) dry, 50% pale brown (10YR 6/3), very pale brown (10YR 7/3) silt loam dry; weak fine prismatic parting to weak fine subangular blocky; friable; noncalcareous; gradual boundary.
1.08–1.80	Bt1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine faint yellowish brown mottles; weak fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; abrupt boundary.
1.80–2.15	2Ab (Bt2)*	midden. dark brown (10YR 3/3) light silty clay loam, dark brown (10YR 4/3) dry; moderate fine and medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; abundant charcoal and burned earth; clear boundary.
2.15–3.55	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine and medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
3.55–4.20	2Btb2	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; few very fine distinct strong brown (7.5YR 4/6) and fine faint yellowish brown (10YR 5/6) mottles; few gray (10YR 5/1) reduction zones along root channels and pores; weak fine and medium prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces; friable; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; noncalcareous; gradual boundary.
4.20–4.70	2BCb	dark yellowish brown (10YR 4/4) light silty clay loam, yellowish brown (10YR 5/4) dry; common very fine and fine distinct strong brown (7.5YR 4/6) and fine faint yellowish brown (10YR 5/6) mottles; common gray (10YR 5/1) reduction zones along root channels and pores; massive to very weak fine subangular blocky; weakly expressed bedding; friable; noncalcareous; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
4.70–5.20+	3C	Stratified dark yellowish brown (10YR 4/4) and dark brown (10YR 4/3) silty clay loam, clay loam, loam, and fine sandy loam, many fine distinct gray (10YR 5/1) and fine prominent yellowish brown (10YR 5/6), strong brown (7.5YR 4/6 and 5/6), yellowish red (5YR 4/6) and dark reddish brown (5YR 3/4) mottles; massive; friable; noncalcareous; many very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations.

Note: Upper 25 cm was stripped off with heavy machinery in the area of this core. Surface soil welded onto 2Ab soil. Midden at 1.80-2.15 m below ground surface.

Core 19

Location: 524.58 E, 493.37 N
Landscape Position: T1a terrace
Altitude: 235.62 m asl

Depth (m)	Horizon	Description
0.00–0.18	Bt1	yellowish brown (10YR 5/4) light silty clay loam, dark yellowish brown (10YR 4/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
0.18–0.38	Bt2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
0.38–0.51	Bt3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine faint yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and common very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; clear boundary.
0.51–0.76	2Ab (Bt4)*	dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark grayish brown (10YR 4/2) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
0.76–1.19	2Btb1	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium prismatic parting to moderate fine subangular blocky, with common continuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
1.19–2.15	2Btb2	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; gradual boundary.
2.15–3.25	2Btb3	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8 and 4/6) mottles; moderate fine prismatic parting to moderate fine subangular blocky, with common discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; few very fine soft ferromanganese accumulations; gradual boundary.
3.25–3.58	2Btb4	dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; few gray (10YR 5/1) reduction zones along root channels; moderate fine prismatic parting to moderate fine subangular blocky, with few discontinuous dark brown (10YR 4/3) clay films on ped faces and lining pores and few discontinuous very pale brown (10YR 7/3) silt coatings on ped faces; friable; noncalcareous; few very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.
3.58–3.84	2Btb5	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; common gray (10YR 5/1) reduction zones along root channels; weak fine prismatic parting to weak fine subangular blocky, with few discontinuous dark brown (7.5YR 4/4) clay films on ped faces, few dark brown (7.5YR 4/4) clay films lining pores; friable; noncalcareous; common very fine and fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; gradual boundary.

Depth (m)	Horizon	Description
3.84–4.46	2BCb	dark brown (7.5YR 4/4) light silty clay loam, brown (7.5YR 5/4) dry; common fine distinct yellowish brown (10YR 5/6) and many strong brown (7.5YR 5/8 and 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; very weak fine subangular blocky; friable; noncalcareous; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; stringer of chert pebbles at 421-422 cm; clear boundary.
4.46–5.00	2Cg1	grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 4/6) and yellowish red (5YR 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; massive; firm; noncalcareous; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; abrupt boundary marked by lens of chert pebbles and a sub-rounded cobble.
5.00–5.35	2Cg2	grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent strong brown (7.5YR 4/6) and yellowish red (5YR 4/6) mottles; many gray (10YR 5/1) reduction zones along root channels and pores; massive; firm; noncalcareous; many fine discontinuous ferromanganese stains and fine soft ferromanganese accumulations; stringer of chert pebbles at 421-422 cm; abrupt boundary marked by lens of chert pebbles and one sub-rounded cobble 5 cm in diameter.
5.35–6.78	2Cg3	dark gray (5Y 4/1) silty clay grading downward to a clay loam, gray (5Y 5/1) dry; common fine faint greenish gray (5GY 5/1) and few fine and medium distinct yellowish red (5YR 4/6) and fine prominent yellowish red (5YR 5/8) mottles; massive; very firm; noncalcareous; abrupt boundary.
6.78–6.85+	3C	Chert gravel; single grain; loose.

Note: Surface soil is welded onto the 2Ab soil. Upper 25 cm was stripped off with heavy machinery in the area of this core.

Cutbank Due South of Blocks B and C

Landscape Position: T1a terrace, on local high point

Depth (m)	Horizon	Description
0.00–0.17	Ap1	dark brown (10YR 3/3) silt loam; moderate fine subangular blocky; friable; noneffervescent; clear to abrupt boundary.
0.17–0.32	Ap2	dark brown (10YR 3/3) silt loam; moderate medium parting to fine angular blocky, with continuous thin very dark grayish brown (10YR 3/2) organic films; friable; noneffervescent; clear to abrupt boundary.
0.32–0.49	Bt1	dark brown to brown (10YR 4/3) heavy silt loam; moderate fine and medium subangular blocky, with continuous thin clay films on ped faces, and few discontinuous silt coatings on ped faces and few lining pores; firm; noneffervescent; clear boundary.
0.49–0.71	Bt2	dark brown to brown (10YR 4/3) heavy silt loam; moderate coarse subangular blocky tending to prismatic, with continuous thin clay films on ped faces, and few discontinuous silt coatings on ped faces and few lining pores; firm; noneffervescent; clear boundary.
0.71–0.95	2Ab (Bt3)*	very dark grayish brown (10YR 3/2) light silty clay loam; moderate fine prismatic parting to moderate fine and medium subangular blocky, with continuous thin clay films on ped faces, and few discontinuous silt coatings on ped faces and few lining pores; firm; noneffervescent; clear boundary.
0.95–1.19	2Btb1	dark to dark yellowish brown (10YR 3/3.5) silty clay loam; very few medium and coarse dark yellowish brown (10YR 3/4) mottles; moderate medium prismatic parting to moderate medium angular blocky, with many continuous very dark grayish brown (10YR 3/2) clay films on ped faces and lining pores, and many discontinuous thin to moderately thick light brownish gray (10YR 6/2) silt coatings on ped faces and interiors; very firm; noneffervescent; few fine ferromanganese concretions; gradual boundary.
1.19–1.64	2Btb2	dark yellowish brown (10YR 3/4) silty clay loam; moderate medium and coarse prismatic parting to moderate medium angular blocky, with, many continuous thin very dark grayish brown (10YR 3/2) clay films and few thin continuous very dark grayish brown (10YR 3/2) lining pores; very firm; noneffervescent; many fine ferromanganese concretions; gradual boundary.

Depth (m)	Horizon	Description
1.64–1.97	2Btb3	dark yellowish brown (10YR 3/4) silty clay loam; moderate coarse prismatic, with many continuous to discontinuous thin very dark grayish brown (10YR 3/2) clay films on ped faces and lining pores; very firm; noneffervescent; common fine ferromanganese concretions; gradual boundary.
1.97–2.81	2Btb4	dark to dark yellowish brown (10YR 3/3.5) light silty clay loam; strong coarse prismatic, with continuous thin dark brown (10YR 3/3) clay films on ped faces and lining pores, and few to common discontinuous thin to moderately thick pale brown (10YR 6/3) and very pale brown (10YR 7/3) silt coatings on ped faces and lining pores; firm; noneffervescent; clear boundary.
2.81–3.33	3Ab (2Btb5)*	dark brown (10YR 3/3) silty clay loam; moderate medium parting to fine angular blocky, with discontinuous thin very dark grayish brown(10YR 3/2) clay films on ped faces and lining pores; firm; noneffervescent; gradual boundary.
3.33–3.69	3Btb1	dark brown to brown (10YR 4/3) silty clay loam; common medium and coarse dark grayish brown (10YR 4/2) oxide depletion zones; moderate coarse parting to medium angular blocky and subangular blocky, with few discontinuous dark brown (10YR 3/3) clay films on ped faces and lining pores; firm; noneffervescent; clear boundary.
3.69–4.00	3Btb2	clay loam, with very few fine pebbles and granules; common medium dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) oxide depletion zones with dark yellowish brown (10YR 3/6) oxidized halos; weak coarse subangular blocky, with very few discontinuous thin dark brown (10YR 3/3) clay films on ped faces and lining pores; firm; noneffervescent; discontinuous thin ferromanganese accumulations on ped faces; clear to abrupt boundary.
4.00–4.33	4BCb	dark yellowish brown (10YR 3/4) light clay loam to loam, with few pebble gravel; common fine dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) oxide depletion zones; very weak coarse subangular blocky over very weakly expressed stratification; firm; noneffervescent; abrupt boundary.
4.33+	5C1	dark yellowish brown to strong brown (10YR–7.5YR 3.5/6) pebbly sandy loam, with some clay, with common fine pebble gravel up to 3 cm diameter; few horizontal dark grayish brown (10YR 4/2) oxide depletion zones mimicking bedding; stratified, very weakly downward to moderately expressed; firm to friable; noneffervescent; abrupt boundary.

APPENDIX 4

PARTICLE-SIZE AND CHEMICAL DATA FOR CORE 2 AND BLOCK B COLUMN

Particle-Size Data for Core 2.

Lab Number	Depth (cm)	Texture Class	Coarse Fragments (%)	Sand: Very Coarse 2.0–1.0 mm (%)	Sand: Coarse 1.0–0.5 mm (%)	Sand: Medium 0.5–0.25 mm (%)	Sand: Fine 0..25–0.10 mm (%)	Sand: Very Fine 0.10–0.05 mm (%)	Sand: Total 2.0–0.05 mm (%)	Silt: Fine 0.02–0.002 mm (%)	Silt: Total 0.05–0.002 mm (%)	Clay: Fine <0.0002 mm (%)	Clay: Total <0.002 mm (%)
D2822	0–12	SiL		0.1	0.4	0.8	3.5	2.6	7.4	52.9	71.7	9.1	20.9
D2823	12–33	SiL		0.0	0.2	0.5	1.9	1.9	4.5	52.5	70.5	12.7	25.0
D2824	33–47	SiCl		0.0	0.0	0.1	0.7	1.4	2.2	53.1	70.6	15.3	27.2
D2825	47–61	SiCl		0.0	0.1	0.2	0.9	1.4	2.6	51.7	68.9	16.4	28.5
D2826	61–75	SiCl		0.0	0.0	0.2	1.2	1.8	3.2	50.2	67.1	17.6	29.7
D2827	75–84	SiCl		0.0	0.1	0.1	1.5	1.8	3.5	49.4	67.6	17.3	28.9
D2828	84–93	SiCl		0.0	0.1	0.1	1.5	1.8	3.5	52.3	67.2	17.0	29.3
D2829	93–104	SiCl		0.0	0.1	0.2	1.4	1.9	3.6	51.4	67.0	17.3	29.4
D2830	104–114	SiCl		0.1	0.2	0.3	1.1	1.8	3.5	47.0	62.4	16.8	34.1
D2831	114–123	SiCl		0.0	0.1	0.3	0.9	1.5	2.8	50.8	64.5	18.7	32.7
D2832	123–133	SiCl		0.0	0.2	0.5	0.9	1.3	2.9	50.4	65.2	18.4	31.9
D2833	133–147	SiCl		0.0	0.4	0.4	0.6	1.1	2.5	50.5	63.6	19.2	33.9
D2834	147–161	SiCl		0.0	0.1	0.2	0.4	0.9	1.6	50.4	64.0	19.7	34.4
D2835	161–178	SiCl		0.0	0.0	0.1	0.3	0.7	1.1	50.4	63.3	20.2	35.6
D2836	178–195	SiCl		0.0	0.0	0.0	0.2	1.0	1.2	49.7	64.8	19.1	34.0
D2837	195–210	SiCl		0.0	0.1	0.1	0.3	1.0	1.5	52.6	65.0	18.3	33.5
D2838	210–230	SiCl		0.0	0.0	0.1	0.3	0.9	1.3	52.1	64.8	18.2	33.9
D2839	230–249	SiCl		0.0	0.0	0.1	0.6	1.2	1.9	49.3	63.3	18.1	34.8
D2840	249–267	SiCl		0.0	0.0	0.4	1.6	2.4	4.4	46.7	61.7	19.4	33.9
D2841	267–279	SiCl		0.0	0.0	0.7	2.7	2.8	6.2	43.3	60.3	20.3	33.5
D2842	279–288	SiCl		0.0	0.0	0.9	3.6	2.9	7.4	43.4	57.5	22.1	35.1
D2843	288–297	SiCl		0.0	0.0	1.1	4.0	3.1	8.2	40.1	55.1	21.9	36.7
D2844	297–306	SiCl		0.0	0.1	1.2	5.2	3.6	10.1	38.7	56.8	22.4	33.1
D2845	306–315	SiCl		0.0	0.1	1.3	6.0	3.8	11.2	36.6	53.0	23.4	35.8
D2846	315–324	SiCl		0.0	0.1	1.5	6.8	4.3	12.7	36.0	52.6	24.2	34.7
D2847	324–333	SiCl		0.0	0.1	1.9	7.5	4.3	13.8	34.5	49.8	25.2	36.4
D2848	333–342	SiCl		0.0	0.1	2.5	9.0	4.2	15.8	32.4	48.8	24.9	35.4
D2849	342–351	SiCl		0.0	0.1	3.6	11.3	4.1	19.1	29.6	45.8	24.5	35.1
D2850	351–360	Cl		0.1	0.3	5.2	14.0	3.9	23.5	29.7	43.5	22.7	33.0
D2851	360–369	Cl	4	0.1	0.5	7.9	18.1	3.9	30.5	25.3	37.4	21.0	32.1
D2852	369–378	Cl		0.2	0.8	10.8	22.1	3.8	37.7	22.8	33.7	19.0	28.6
D2853	378–386	Cl		0.5	1.2	12.5	24.3	3.7	42.2	20.0	29.4	18.7	28.4
D2854	386–400	SCl	33	6.1	2.8	13.6	25.7	3.3	51.5	15.2	25.5	15.8	23.0
D2855	400–411	SCl		0.0	0.4	13.7	31.2	3.9	49.2	17.3	27.2	16.3	23.6
D2856	411–424	SCl		0.2	0.9	15.8	31.2	3.8	51.9	14.9	25.0	15.3	23.1
D2857	424–435	SCl		0.0	0.5	13.9	31.6	4.2	50.2	14.3	25.6	16.0	24.2
D2858	435–450	FSL		0.1	2.0	25.0	38.3	2.3	67.7	8.7	14.2	12.5	18.1
D2859	450–458	SL	17	0.8	6.0	27.3	28.7	2.2	65.0	10.4	17.0	12.0	18.0
D2860	458–464	SL	64	9.3	11.9	27.3	19.3	2.4	70.2	8.1	14.1	10.5	15.7

Chemical Data and Clay Mineralogy for Core 2.

						Clay Mineralogy				
Lab Number	Depth (cm)	Organic Carbon (%)	pH	Total Phosphorous	Available Phosphorous	Expandables (%)	Illite (%)	Kaolinite + Chlorite (%)	Heterogeneous Swelling Ratio	Diffraction Index
D2822	0–12	1.36	5.8	370	7	11	76	13	24	2.6
D2823	12–33	0.83		365	7	21	64	15	64	1.1
D2824	33–47	0.54	6.6	377	18	18	67	15	43	2.0
D2825	47–61	0.51	6.6	413	20	20	64	16	53	1.8
D2826	61–75	0.46	6.4	470	29	23	62	15	102	1.8
D2827	75–84	0.49		454	26	25	62	13	105	2.0
D2828	84–93	0.51	6.6	450	25	19	68	13	62	2.3
D2829	93–104	0.54	6.6	441	27	17	68	15	73	2.1
D2830	104–114	0.56	6.5	408	24	18	67	15	67	2.0
D2831	114–123	0.60	6.5	455	27	17	66	17	75	1.8
D2832	123–133	0.60	6.5	426	24	16	68	16	70	1.9
D2833	133–147	0.59	6.5	456	25	16	66	18	77	1.8
D2834	147–161	0.54	6.4	449	23	26	53	21	134	1.1
D2835	161–178	0.48	6.5	466	23	13	71	15	80	2.1
D2836	178–195	0.42	6.3	452	24	22	59	19	119	1.4
D2837	195–210	0.40	6.3	437	26	20	62	18	144	1.5
D2838	210–230	0.41	6.4	461	27	24	58	18	146	1.5
D2839	230–249	0.40	6.7	485	29	21	62	17	97	1.7
D2840	249–267	0.39	6.4	483	31	21	63	16	122	1.8
D2841	267–279	0.39	6.4	478	30	24	61	15	122	1.8
D2842	279–288	0.48	6.9	464	29	20	65	15	77	1.9
D2843	288–297	0.47	6.3	479	28	32	51	17	155	1.3
D2844	297–306	0.50	6.3	475	27	31	52	17	197	1.3
D2845	306–315	0.53	6.3	481	22	29	55	16	165	1.5
D2846	315–324	0.50	6.0	505	25	24	61	15	132	1.9
D2847	324–333	0.43	6.2	482	22	37	48	15	222	0.82
D2848	333–342	0.37	6.2	489	27	32	52	16	219	1.4
D2849	342–351	0.34	6.3	496	27	30	53	17	198	1.4
D2850	351–360	0.31	6.3	500	26	35	51	14	248	1.7
D2851	360–369	0.27	6.4	482	28	31	56	13	199	2.0
D2852	369–378	0.24	6.4	413	21	27	60	13	211	2.0
D2853	378–386	0.21	6.4	416	23	28	59	13	228	2.1
D2854	386–400	0.18	6.4	397	20	32	55	13	225	1.9
D2855	400–411	0.17	6.4	419	22	28	59	13	233	2.1
D2856	411–424	0.17	6.6	411	21	21	68	11	183	2.9
D2857	424–435	0.16	6.4	400	23	25	62	13	178	2.1
D2858	435–450	0.14	6.6	346	20	27	59	14	177	1.8
D2859	450–458	0.14	6.4	356	20	22	66	12	183	2.4
D2860	458–464	0.16		381	16	30	55	15	171	1.7

Particle-Size Data for Block B Column.

Sample	Depth (cm)	Horizon	Sand: Very Coarse 2.0–0.35 mm (%)	Sand: Coarse 0.35–0.25 mm (%)	Sand: Medium 0.25–0.177 mm (%)	Sand: Fine 0.177–0.125 mm (%)	Sand: Very Fine 0.125–0.088 mm (%)	Sand: 0.088–0.0625 mm (%)	Sand: Total 2.0–0.0625 mm (%)	Silt: Coarse 62.5μ–32μ (%)	Silt: Medium 32μ–16μ (%)	Silt: Fine 16μ–2μ (%)	Silt: Total	Clay: Coarse 2μ–1μ (%)	Clay: Fine <1μ (%)	Clay: Total
1	0–2	Ap	0.3	0.4	0.9	1.2	1.1	0.6	4.6	8.5	28.7	41.7	78.9	4.8	11.5	16.3
2	10–12	Ap	0.4	0.4	1.1	1.3	1.1	0.9	5.2	9.5	26.4	37.9	73.8	4.0	16.8	20.8
3	20–22	AB	0.4	0.2	0.3	0.6	0.6	0.5	2.7	4.2	25.8	43.3	73.3	4.6	19.3	23.9
4	30–32	AB	0.3	0.2	0.3	0.4	0.4	0.6	2.1	5.2	25.7	42.7	73.6	4.4	19.8	24.2
5	40–42	Bt1	0.2	0.2	0.3	0.3	0.4	0.5	1.9	5.2	25.5	42.7	73.4	4.4	20.2	24.6
6	50–52	Bt1	0.2	0.1	0.2	0.4	0.5	0.4	1.7	5.5	24.0	42.9	72.4	3.9	21.9	25.8
7	60–62	Bt1	0.1	0.1	0.2	0.3	0.4	0.5	1.7	5.3	22.6	42.9	70.8	4.8	22.6	27.4
8	70–72	Bt2	0.2	0.1	0.2	0.5	0.6	0.4	2.0	3.7	22.8	42.6	69.1	4.0	24.8	28.8
9	80–82	Bt2	0.2	0.1	0.3	0.6	0.7	0.5	2.5	4.4	22.7	41.1	68.2	4.3	25.0	29.3
10	90–92	2Ab (Bt3)[a]	0.3	0.1	0.3	0.6	0.7	0.8	2.9	4.3	23.2	40.9	68.4	4.0	24.7	28.7
11	100–102	2Ab (Bt3)[a]	0.6	0.2	0.3	0.7	0.7	0.5	3.0	5.8	21.2	41.1	68.1	4.1	24.8	28.9
12	110–112	2Ab (Bt3)[a]	0.8	0.2	0.3	0.6	0.7	0.5	3.1	5.0	22.3	40.7	68.0	3.2	25.6	28.8
13	120–122	2Ab (Bt3)[a]	1.1	0.3	0.3	0.3	0.5	0.5	3.0	4.9	21.0	40.3	66.2	3.8	27.0	30.8
14	130–132	2Ab (Bt3)[a]	1.7	0.3	0.3	0.3	0.4	0.4	3.4	3.6	20.2	41.7	65.5	3.8	27.2	31.0
15	140–142	2ABtb	1.2	0.3	0.2	0.3	0.4	0.3	2.7	3.4	19.2	41.8	64.4	3.9	28.9	32.8
16	150–152	2Btb1	0.8	0.2	0.2	0.3	0.3	0.3	2.0	3.8	17.7	43.0	64.5	4.3	29.1	33.4
17	160–162	2Btb1	0.2	0.1	0.1	0.1	0.2	0.3	1.0	3.1	17.8	44.8	65.7	4.4	28.9	33.3
18	170–172	2Btb2	0.0	0.0	0.1	0.1	0.1	0.2	0.6	4.9	17.7	43.9	66.5	4.1	28.8	32.9
19	180–182	2Btb2	0.0	0.0	0.1	0.1	0.2	0.3	0.8	5.4	18.7	42.5	66.6	4.6	28.0	32.6
20	190–192	2Btb3	0.0	0.1	0.1	0.2	0.3	0.3	0.9	4.7	17.9	45.2	67.8	4.6	26.6	31.2
21	200–202	2Btb3	0.0	0.1	0.1	0.2	0.3	0.3	1.0	3.4	19.5	43.8	66.7	5.4	26.8	32.2
22	210–212	2Btb4	0.0	0.1	0.1	0.2	0.3	0.3	1.0	3.1	19.8	44.1	67.0	4.7	27.2	31.9
23	220–222	2Btb4	0.0	0.1	0.2	0.2	0.2	0.3	0.9	4.9	17.7	45.0	67.6	4.5	26.9	31.4
24	230–232	2Btb4	0.0	0.1	0.2	0.3	0.3	0.2	1.0	3.5	16.7	46.3	66.5	4.6	27.9	32.5
25	240–242	2Btb4	0.0	0.1	0.2	0.3	0.3	0.4	1.3	3.6	16.0	45.5	65.1	4.5	29.0	33.5
26	250–252	2Btb5							0.0	–	–	–		–	–	
27	260–262	2Btb5							0.0	–	–	–		–	–	
28	249–251	2Btb5	0.1	0.4	0.8	1.2	1.0	0.7	4.1	6.4	19.4	38.4	64.2	3.5	28.1	31.6
29	257–259		0.1	0.4	1.2	1.4	1.2	1.1	5.3	7.5	20.1	35.9	63.5	3.4	27.7	31.1
30	265–269	2Btb5	0.1	0.6	1.4	2.0	1.5	0.9	6.5	12.8	14.7	34.5	62.0	3.1	28.2	31.3
31	272–274	2Btb5	0.2	0.7	2.0	2.4	1.8	1.4	8.3	6.6	20.7	32.5	59.8	3.2	28.6	31.8
32	280–282	2Btb5	0.2	1.0	2.4	3.3	2.3	1.2	10.4	5.8	20.4	31.1	57.3	3.2	28.9	32.1
33	290–292	3Ab (2Btb6)[a]	0.2	1.2	2.9	3.7	2.7	1.4	12.0	2.7	21.1	31.3	55.1	3.1	29.5	32.6
34	297–299	3Ab (2Btb6)[a]	0.2	1.0	3.4	4.0	3.0	2.1	13.7	8.1	18.4	27.0	53.5	3.2	29.4	32.6
35	305–307	3Ab (2Btb6)[a]	0.3	1.4	3.4	4.6	3.3	1.6	14.6	9.4	16.7	25.0	51.1	3.0	31.1	34.1
36	313–315	3Ab (2Btb6)[a]	0.3	1.3	3.7	4.6	3.4	1.7	14.9	6.5	18.6	25.0	50.1	3.5	31.2	34.7
37	321–323	3Ab (2Btb6)[a]	0.2	1.0	3.4	3.4	2.7	1.9	12.7	20.2	15.5	21.4	57.1	2.4	27.6	30.0
38	330–332	3Bt1	0.4	1.7	3.9	4.4	3.1	1.6	15.2	5.9	17.6	25.5	49.0	2.8	32.6	35.4
39	338–340	3Bt1	0.5	1.6	4.8	4.3	2.9	2.0	16.0	5.4	17.5	25.4	48.3	3.0	32.3	35.3
40	346–348	3Bt1	0.8	2.5	4.4	4.1	2.9	1.5	16.1	4.6	17.9	25.3	47.8	3.3	31.9	35.2
41	354–356	3Bt2	1.1	2.8	4.9	4.6	2.8	1.4	17.5	6.0	16.0	25.4	47.4	3.1	31.7	34.8
42	363–365	3Bt2	1.2	3.4	6.7	4.6	2.7	1.8	20.4	5.4	16.2	23.4	45.0	3.5	30.9	34.4
43	371–373	3Bt2	2.1	5.5	7.8	6.0	3.1	1.3	25.7	5.9	14.7	21.0	41.6	2.9	29.5	32.4
44	379–381	3Bt1	2.4	7.1	11.4	6.7	3.4	1.8	32.8	4.3	14.6	18.5	37.4	2.3	27.2	29.5
45	388–390	4BCb	3.5	10.1	13.9	7.5	3.5	1.7	40.2	4.0	12.3	15.9	32.2	2.6	24.7	27.3

[a]Welded soil.

Soil Chemistry and Clay Mineralogy for Block B Column.

Sample	Depth (cm)	Horizon	Carbon (%)	Organic Carbon (%)	Nitrogen (%)	pH	Total Phosphorous (mg/kg)	Available Phosphorous (mg/kg)	Expandables (%)	Illite (%)	K+C (%)
1	0–2	Ap	2.15	2.53	0.21	5.1	476	22.1	23	55	22
2	10–12	Ap	1.21	1.15	0.12	5.3	392	2.7	34	47	20
3	20–22	AB	0.86	0.80	0.08	5.9	356	2.5	44	41	15
4	30–32	AB	0.64	0.56	0.07	6.2	294	5.7	43	39	17
5	40–42	Bt1	0.55	0.46	0.05	6.3	326	8.8	43	39	18
6	50–52	Bt1	0.45	0.37	0.05	6.4	328	16.0	46	36	18
7	60–62	Bt1	0.42	0.33	0.04	6.4	348	22.5	20	55	25
8	70–72	Bt2	0.41	0.30	0.05	6.4	349	27.9	29	41	29
9	80–82	Bt2	0.41	0.30	0.04	6.4	372	29.4	42	41	16
10	90–92	2Ab (Bt3)[a]	0.44	0.34	0.05	6.5	364	31.0	41	44	15
11	100–102	2Ab (Bt3)[a]	0.52	0.39	0.05	6.4	360	31.8	29	51	19
12	110–112	2Ab (Bt3)[a]	0.52	0.39	0.05	6.5	377	29.9	41	43	16
13	120–122	2Ab (Bt3)[a]	0.56	0.46	0.05	6.5	395	29.8	41	38	21
14	130–132	2Ab (Bt3)[a]	0.58	0.45	0.06	6.0	399	27.8	42	41	18
15	140–142	2ABtb	0.58	0.44	0.06	5.8	385	26.8	38	43	19
16	150–152	2Btb1	0.52	0.38	0.05	5.8	454	27.6	39	41	20
17	160–162	2Btb1	0.45	0.32	0.05	5.6	370	25.7	43	37	20
18	170–172	2Btb2	0.40	0.28	0.05	5.7	406	24.9	41	44	15
19	180–182	2Btb2	0.37	0.25	0.05	5.7	380	25.3	38	45	18
20	190–192	2Btb3	0.35	0.23	0.04	5.7	350	25.0	34	44	22
21	200–202	2Btb3	0.34	0.22	0.04	5.7	354	24.5	44	40	15
22	210–212	2Btb4	0.34	0.23	0.04	5.6	368	24.8	41	42	17
23	220–222	2Btb4	0.36	0.24	0.05	5.6	377	25.7	37	44	19
24	230–232	2Btb4	0.37	0.27	0.05	5.5	374	28.3	39	44	18
25	240–242	2Btb4	0.38	0.27	0.05	5.6	354	26.3	32	47	21

Soil Chemistry and Clay Mineralogy for Block B Column, continued.

Sample	Depth (cm)	Horizon	Carbon (%)	Organic Carbon (%)	Nitrogen (%)	pH	Total Phosphorous (mg/kg)	Available Phosphorous (mg/kg)	Expandables (%)	Illite (%)	K+C (%)
26	250–252	2Btb5	--	--	--	--	--	--	--	--	--
27	260–262	2Btb5	--	--	--	--	--	--	--	--	--
28	249–251	2Btb5	0.36	0.25	0.04	5.5	395	28.4	40	41	19
29	257–259		0.34	0.25	0.04	5.6	404	29.2	48	37	15
30	265–269	2Btb5	0.37	0.25	0.04	5.7	390	28.7	45	38	17
31	272–274	2Btb5	0.40	0.30	0.04	5.6	389	31.2	46	40	15
32	280–282	2Btb5	0.43	0.31	0.05	5.6	431	33.1	53	34	13
33	290–292	3Ab (2Btb6)[a]	0.50	0.41	0.05	5.8	453	36.2	42	44	14
34	297–299	3Ab (2Btb6)[a]	0.54	0.42	0.05	5.9	468	36.2	46	39	15
35	305–307	3Ab (2Btb6)[a]	0.50	0.39	0.05	5.9	490	38.9	48	37	15
36	313–315	3Ab (2Btb6)[a]	0.45	0.37	0.05	6.1	505	38.6	40	41	19
37	321–323	3Ab (2Btb6)[a]	0.39	0.31	0.04	6.1	528	40.0	43	38	20
38	330–332	3Bt1	0.36	0.28	0.04	6.0	497	40.0	48	37	16
39	338–340	3Bt1	0.32	0.26	0.04	6.0	499	41.1	44	41	15
40	346–348	3Bt1	0.31	0.22	0.04	6.2	515	40.4	44	37	19
41	354–356	3Bt2	0.30	0.23	0.04	6.2	504	40.2	50	36	14
42	363–365	3Bt2	0.30	0.22	0.04	6.3	504	38.6	46	39	16
43	371–373	3Bt2	0.27	0.21	0.03	6.2	473	38.6	45	39	16
44	379–381	3Bt1	0.23	0.17	0.03	6.1	467	38.0	44	39	16
45	388–390	4BCb	0.22	0.16	0.02	6.1	432	34.3	39	43	18
46	387–399	4BCb	0.22	0.14	0.03	6.2	415	32.8	37	47	15

[a]Welded soil.

APPENDIX 5

LITHIC DATA

Lithic Data Codes.

Category/Code	Description	Category/Code	Description
Provenience		Cortex Type	
PCM	Private collection, McCurdy	S	Stream deposited (alluvial)
PCL	Private collection, Long	R	Residual
PCCC	Private collection, C. Collins	I	Indeterminate
PCTC	Private collection, T. Collins	X	Cortex not present
PCB	Private collection, Brauer	Fragment Type	
A-BD	Block A backdirt	E	Edge
ASS	Block A shovel skimming	F	Production failure
ATS	Block A trackhoe scraping	H	Heat
B-BD	Block B backdirt	K	Killed
BT	Backhoe Trench	U	Use failure
BTS	Block B trackhoe scraping	Break Type	
C-BD	Block C backdirt	A	Artificial (shovel)
CB	Cutbank in situ	B	Burinated
CTS	Block C trackhoe scraping	C	Complete
D-BD	Block D backdirt	D	Diagonal
ER-S	Early Rodgers cutbank slumpage	EO	End overshot
F	Feature	I	Impact
G-S	General cutbank slumpage	IF	Incipient fracture
GB	Gravel bar (west side)	L	Longitudinal
LR-S	Late Rodgers cutbank slumpage	M	Multiple
MR-S	Middle Rodgers cutbank slumpage	SO	Side overshot
SS-MR	Stripped surface Middle Rodgers	T	Transverse
PPK	Stripped surface projectile point/knife	Component	
SSB-G	Stripped surface backdirt, general	01WM	Woodland/Mississippian,
SSB-NE	Stripped surface backdirt, northeast	021W	Woodland, undifferentiated
TU	Test unit	022WLA	Woodland/Late Archaic
PZBD	Plow-zone backdirt	03LLA	Late Late Archaic
T-1b/T-1a	Middle/Late Rodgers	03MLA	Middle Late Archaic
Raw Material		04ELA	Early Late Archaic
Ex	Exotic chert, unidentified	05MA	Middle Archaic
Mbk	Burlington chert	06LEA	Late Early Archaic
Mch	Chouteau chert	07EEA	Early Early Archaic
Mpk	Pitkin chert	08LP	Late Paleoindian
Mp-r	Pierson chert, Red variety	09EMP	Early/Middle Paleoindian
Mrs-l	Reeds Spring chert, Lower variety	Type Period	
Mrs-m	Reeds Spring chert, Middle variety	00M	Middle Mississippian
Ojcc-b	Jefferson City chert, Banded variety	01LW/M	Late Woodland/Early Mississippian
Ojcc-c	Jefferson City chert, Conglomeritic variety	021W	Woodland, undifferentiated
Ojcc-e	Jefferson City chert, Ellipsoidal variety	03LLA	Late Late Archaic
Ojcc-m	Jefferson City chert, Mottled variety	03MLA	Middle Late Archaic
Ojcc-o	Jefferson City chert, Oolitic variety	04ELA	Early Late Archaic
Ojcc-q	Jefferson City chert, Quartzitic variety	05MA	Middle Archaic
Ojcq	Jefferson City quartzite	06LEA	Late Early Archaic
Pdw	Winterset chert	07EEA	Early Early Archaic
Pfb	Florence B chert	08LP	Late Paleoindian
Pw-bk	Warner chert, Burlington variety	09EMP	Early/Middle Paleoindian
Pw-ch	Warner chert, Chouteau variety		
U-Mbk	Undifferentiated Burlington		
U-Mch	Undifferentiated Chouteau		
U-Ojcc	Undifferentiated Jefferson City		

Feature Debitage Data.

Feature	Type	Raw Material	N	Cobble	Cobble Reduction Stages	Component
1	Flake fragment	Mbk	4			01WM
1	Biface flake	Ojcc-m	1			01WM
1	Flake fragment	Ojcc-e	1			01WM
1	Secondary flake	Mch	1			01WM
6	Tertiary flake	Mbk	2			01WM
6	Flake fragment	Mbk	2			01WM
7	Biface flake	Mbk	1			01WM
7	Flake fragment	Mbk	3			01WM
12	Flake fragment	Mbk	1			01WM
15	Tertiary flake	Ojcc-e	1			01WM
15	Biface flake	Ojcc-e	2			01WM
15	Flake fragment	Ojcc-e	1			01WM
16	Tertiary flake	Mbk	1			01WM
16	Flake fragment	Mbk	1			01WM
17	Flake fragment	Mbk	1			04ELA
18	Tertiary flake	Mbk	1			03MLA
18	Tertiary flake	Ojcc-e	1			03MLA
18	Flake fragment	Ojcc-e	1			03MLA
20	Secondary flake	Mbk	1			03MLA
20	Tertiary flake	Mbk	2			03MLA
20	Biface flake	Mbk	2			03MLA
20	Flake fragment	Mbk	4			03MLA
22	Biface flake	Mbk	1			03MLA
23	Secondary flake	Ojcc-e	2	23-01	3-4	08LP
23	Tertiary flake	Ojcc-e	1	23-01	3-4	08LP
23	Biface flake	Ojcc-e	7	23-01	3-4	08LP
23	Flake fragment	Ojcc-e	4	23-01	3-4	08LP
23	Primary flake	Ojcc-e	5	23-02	1-2	08LP
23	Secondary flake	Ojcc-e	1	23-02	1-2	08LP
23	Biface flake	Ojcc-e	5	23-02	1-2	08LP
23	Flake fragment	Ojcc-e	8	23-02	1-2	08LP
23	Secondary flake	Ojcc-e	2	23-03	2-3	08LP
23	Biface flake	Ojcc-e	1	23-03	2-3	08LP
23	Flake fragment	Ojcc-e	2	23-03	2-3	08LP
23	Secondary flake	Ojcc-e	2	23-04	1-2	08LP
23	Biface flake	Ojcc-e	1	23-04	1-2	08LP
23	Flake fragment	Ojcc-e	2	23-04	1-2	08LP
23	Flake fragment	Ojcc-e	3	23-05	2-3	08LP
24	Primary flake	Ojcc-e	2	24-01	1-2	08LP
24	Secondary flake	Ojcc-e	2	24-01	1-2	08LP
24	Tertiary flake	Ojcc-e	1	24-01	1-2	08LP
24	Biface flake	Ojcc-e	5	24-01	1-2	08LP
24	Flake fragment	Ojcc-e	14	24-01	1-2	08LP
24	Primary flake	Ojcc-e	5	24-02	2-3	08LP
24	Secondary flake	Ojcc-e	3	24-02	2-3	08LP
24	Biface flake	Ojcc-e	53	24-02	2-3	08LP
24	Flake fragment	Ojcc-e	31	24-02	2-3	08LP
26	Biface flake	Mch	1	26-01	1	08LP
26	Flake fragment	Mch	3	26-01	1	08LP
26	Flake fragment	Mch	3	26-02	1	08LP
26	Primary flake	Ojcc-e	1	26-03	1-2	08LP
26	Secondary flake	Ojcc-e	2	26-03	1-2	08LP
26	Tertiary flake	Ojcc-e	2	26-03	1-2	08LP
26	Biface flake	Ojcc-e	3	26-03	1-2	08LP
26	Flake fragment	Ojcc-e	17	26-03	1-2	08LP
26	Tertiary flake	Ojcc-e	2	26-04	4	08LP
26	Biface flake	Ojcc-e	2	26-04	4	08LP
26	Flake fragment	Ojcc-e	5	26-04	4	08LP
26	Secondary flake	Ojcc-e	3	26-05	1-2	08LP
26	Biface flake	Ojcc-e	1	26-05	1-2	08LP

Feature Debitage Data.

Feature	Type	Raw Material	N	Cobble	Cobble Reduction Stages	Component
26	Flake fragment	Ojcc-e	3	26-05	1-2	08LP
26	Biface flake	Ojcc-e	1	26-06	3-4	08LP
26	Flake fragment	Ojcc-e	3	26-06	3-4	08LP
26	Biface flake	Ojcc-e	2	26-07	3-4	08LP
26	Flake fragment	Ojcc-e	3	26-08	1	08LP
26	Primary flake	Ojcc-e	1	26-09	1	08LP
26	Secondary flake	Ojcc-e	1	26-09	1	08LP
26	Flake fragment	Ojcc-e	1	26-09	1	08LP
26	Primary flake	Ojcc-b	1	26-10	1-2	08LP
26	Secondary flake	Ojcc-b	1	26-10	1-2	08LP
26	Biface flake	Ojcc-b	2	26-10	1-2	08LP
26	Flake fragment	Ojcc-b	3	26-10	1-2	08LP
26	Secondary flake	Ojcc-b	1	26-11	2-4	08LP
26	Biface flake	Ojcc-b	2	26-11	2-4	08LP
26	Flake fragment	Ojcc-b	4	26-11	2-4	08LP
26	Biface flake	Ojcc-b	1	26-12	3-4	08LP
26	Flake fragment	Ojcc-b	2	26-12	3-4	08LP
26	Biface flake	Ojcc-e	4	26-U-Ojcc-e	1-4	08LP
26	Flake fragment	Ojcc-e	11	26-U-Ojcc-e	1-4	08LP
26	Flake fragment	Ojcc-b	2	26-U-Ojcc-b	3-4	08LP
27	Secondary flake	Ojcc-e	1	27-01	1-2	08LP
27	Biface flake	Ojcc-e	3	27-01	1-2	08LP
27	Flake fragment	Ojcc-e	3	27-01	1-2	08LP
27	Biface flake	Ojcc-e	7	27-02	3-4	08LP
27	Flake fragment	Ojcc-e	7	27-02	3-4	08LP
28	Tertiary flake	Mbk	1	28-01	2	08LP
28	Biface flake	Mbk	7	28-01	2	08LP
28	Flake fragment	Mbk	5	28-01	2	08LP
28	Secondary flake	Mbk	2	28-02	2	08LP
28	Biface flake	Mbk	10	28-02	2	08LP
28	Flake fragment	Mbk	8	28-02	2	08LP
28	Secondary flake	Mbk	3	28-03	2	08LP
28	Biface flake	Mbk	11	28-03	2	08LP
28	Flake fragment	Mbk	1	28-03	2	08LP
28	Primary flake	Mbk	2	28-U-Mbk	1-2	08LP
28	Secondary flake	Mbk	6	28-U-Mbk	1-2	08LP
28	Biface flake	Mbk	12	28-U-Mbk	1-2	08LP
28	Flake fragment	Mbk	13	28-U-Mbk	1-2	08LP
28	Tertiary flake	Mch	2	28-04	2	08LP
28	Biface flake	Mch	2	28-04	2	08LP
28	Flake fragment	Mch	1	28-04	2	08LP
28	Biface flake	Mch	8	28-05	2	08LP
28	Flake fragment	Mch	3	28-05	2	08LP
28	Secondary flake	Mch	1	28-06	2	08LP
28	Flake fragment	Mch	1	28-06	2	08LP
28	Biface flake	Mch	24	28-07	2-4	08LP
28	Flake fragment	Mch	29	28-07	2-4	08LP
28	Primary flake	Mch	1	28-U-Mch	2-4	08LP
28	Secondary flake	Mch	2	28-U-Mch	2-4	08LP
28	Tertiary flake	Mch	2	28-U-Mch	2-4	08LP
28	Biface flake	Mch	50	28-U-Mch	2-4	08LP
28	Flake fragment	Mch	49	28-U-Mch	2-4	08LP
28	Biface flake	Ojcc-b	4	28-08	2	08LP
28	Flake fragment	Ojcc-b	8	28-08	2	08LP
28	Primary flake	Ojcc-b	1	28-09	1-2	08LP
28	Secondary flake	Ojcc-b	1	28-09	1-2	08LP
28	Biface flake	Ojcc-b	4	28-10	2	08LP
28	Flake fragment	Ojcc-b	2	28-10	2	08LP
28	Biface flake	Ojcc-b	3	28-11	2	08LP
28	Flake fragment	Ojcc-b	1	28-11	2	08LP
28	Biface flake	Ojcc-b	3	28-12	2	08LP

Feature Debitage Data.

Feature	Type	Raw Material	N	Cobble	Cobble Reduction Stages	Component
28	Flake fragment	Ojcc-b	2	28-13	1-2	08LP
28	Biface flake	Ojcc-b	2	28-14	2	08LP
28	Secondary flake	Ojcc-b	1	28-15	2	08LP
28	Flake fragment	Ojcc-b	1	28-15	2	08LP
28	Flake fragment	Ojcc-b	2	28-16	2	08LP
28	Biface flake	Ojcc-b	1	28-17	2	08LP
28	Flake fragment	Ojcc-b	1	28-17	2	08LP
28	Secondary flake	Ojcc-b	2	28-18	1-2	08LP
28	Flake fragment	Ojcc-b	2	28-18	1-2	08LP
28	Biface flake	Ojcc-b	1	28-19	2	08LP
28	Flake fragment	Ojcc-b	1	28-19	2	08LP
28	Primary flake	Ojcc-b	1	28-20	1-2	08LP
28	Flake fragment	Ojcc-b	1	28-20	1-2	08LP
28	Tertiary flake	Ojcc-b	1	28-21	2	08LP
28	Flake fragment	Ojcc-b	1	28-21	2	08LP
28	Primary flake	Ojcc-b	3	28-U-Ojcc-b	1-4	08LP
28	Secondary flake	Ojcc-b	19	28-U-Ojcc-b	1-4	08LP
28	Tertiary flake	Ojcc-b	9	28-U-Ojcc-b	1-4	08LP
28	Biface flake	Ojcc-b	195	28-U-Ojcc-b	1-4	08LP
28	Flake fragment	Ojcc-b	266	28-U-Ojcc-b	1-4	08LP
28	Biface flake	Ojcc-e	4	28-22	3-4	08LP
28	Biface flake	Ojcc-e	1	28-23	2	08LP
28	Flake fragment	Ojcc-e	1	28-23	2	08LP
28	Biface flake	Ojcc-e	1	28-24	2	08LP
28	Flake fragment	Ojcc-e	1	28-24	2	08LP
28	Secondary flake	Ojcc-e	2	28-25	1	08LP
28	Secondary flake	Ojcc-e	2	28-26	1	08LP
28	Tertiary flake	Ojcc-e	1	28-26	1	08LP
28	Biface flake	Ojcc-e	1	28-26	1	08LP
28	Flake fragment	Ojcc-e	2	28-26	1	08LP
28	Biface flake	Ojcc-e	4	28-27	3-4	08LP
28	Flake fragment	Ojcc-e	3	28-27	3-4	08LP
28	Biface flake	Ojcc-e	1	28-28	2	08LP
28	Flake fragment	Ojcc-e	1	28-28	2	08LP
28	Biface flake	Ojcc-e	31	28-29	2-4	08LP
28	Flake fragment	Ojcc-e	31	28-29	2-4	08LP
28	Biface flake	Ojcc-e	2	28-30	2	08LP
28	Primary flake	Ojcc-e	1	28-31	1-2	08LP
28	Secondary flake	Ojcc-e	2	28-31	1-2	08LP
28	Biface flake	Ojcc-e	7	28-31	1-2	08LP
28	Flake fragment	Ojcc-e	4	28-31	1-2	08LP
28	Secondary flake	Ojcc-e	3	28-32	2	08LP
28	Tertiary flake	Ojcc-e	1	28-32	2	08LP
28	Biface flake	Ojcc-e	2	28-32	2	08LP
28	Secondary flake	Ojcc-e	1	28-33	1-2	08LP
28	Flake fragment	Ojcc-e	1	28-33	1-2	08LP
28	Secondary flake	Ojcc-e	2	28-34	1	08LP
28	Flake fragment	Ojcc-e	1	28-34	1	08LP
28	Biface flake	Ojcc-e	1	28-35	2	08LP
28	Flake fragment	Ojcc-e	1	28-35	2	08LP
28	Primary flake	Ojcc-e	2	28-36	1	08LP
28	Secondary flake	Ojcc-e	2	28-37	2	08LP
28	Biface flake	Ojcc-e	1	28-38	2	08LP
28	Flake fragment	Ojcc-e	1	28-38	2	08LP
28	Flake fragment	Ojcc-e	3	28-39	1-2	08LP
28	Secondary flake	Ojcc-e	2	28-45	1-2	08LP
28	Flake fragment	Ojcc-e	1	28-45	1-2	08LP
28	Primary flake	Ojcc-e	11	28-U-Ojcc-e	1-4	08LP
28	Secondary flake	Ojcc-e	27	28-U-Ojcc-e	1-4	08LP
28	Tertiary flake	Ojcc-e	2	28-U-Ojcc-e	1-4	08LP
28	Biface flake	Ojcc-e	100	28-U-Ojcc-e	1-4	08LP

Feature Debitage Data.

Feature	Type	Raw Material	N	Cobble	Cobble Reduction Stages	Component
28	Flake fragment	Ojcc-e	139	28-U-Ojcc-e	1-4	08LP
28	Primary flake	Ojcc-m	1	28-40	1	08LP
28	Flake fragment	Ojcc-m	1	28-40	1	08LP
28	Secondary flake	Ojcc-m	2	28-41	2-4	08LP
28	Tertiary flake	Ojcc-m	1	28-41	2-4	08LP
28	Biface flake	Ojcc-m	3	28-41	2-4	08LP
28	Flake fragment	Ojcc-m	6	28-41	2-4	08LP
28	Secondary flake	Ojcc-m	2	28-42	2-4	08LP
28	Biface flake	Ojcc-m	12	28-42	2-4	08LP
28	Flake fragment	Ojcc-m	18	28-42	2-4	08LP
28	Biface flake	Ojcc-m	2	28-43	3-4	08LP
28	Flake fragment	Ojcc-m	1	28-43	3-4	08LP
28	Tertiary flake	Ojcc-m	1	28-46	2	08LP
28	Biface flake	Ojcc-m	1	28-46	2	08LP
28	Secondary flake	Ojcc-m	2	28-U-Ojcc-m	2-4	08LP
28	Tertiary flake	Ojcc-m	5	28-U-Ojcc-m	2-4	08LP
28	Biface flake	Ojcc-m	32	28-U-Ojcc-m	2-4	08LP
28	Flake fragment	Ojcc-m	82	28-U-Ojcc-m	2-4	08LP
28	Biface flake	Ojcc-o	2	28-U-Ojcc-o	2-4	08LP
28	Flake fragment	Ojcc-o	2	28-U-Ojcc-o	2-4	08LP
28	Primary flake	Ojcc-q	1	28-U-Ojcc-q	1	08LP
28	Secondary flake	Ojcc-b	2	28-44	1-2	08LP
28	Biface flake	Ojcc-b	3	28-44	1-2	08LP
28	Flake fragment	Ojcc-b	3	28-44	1-2	08LP
29	Secondary flake	Ojcc-b	1	29-01	2-4	08LP
29	Biface flake	Ojcc-b	6	29-01	2-4	08LP
29	Flake fragment	Ojcc-b	11	29-01	2-4	08LP
29	Secondary flake	Ojcc-b	3	29-02	1-2	08LP
29	Biface flake	Ojcc-b	4	29-02	1-2	08LP
29	Flake fragment	Ojcc-b	9	29-02	1-2	08LP
29	Primary flake	Ojcc-b	1	29-03	1-2	08LP
29	Biface flake	Ojcc-b	1	29-03	1-2	08LP
29	Secondary flake	Ojcc-e	1	29-04	1-2	08LP
29	Flake fragment	Ojcc-e	2	29-04	1-2	08LP
29	Biface flake	Ojcc-e	2	29-05	3-4	08LP
29	Biface flake	Ojcc-e	2	29-06	2-4	08LP
29	Biface flake	Ojcc-e	1	29-07	2	08LP
29	Flake fragment	Ojcc-e	1	29-07	2	08LP
29	Secondary flake	Ojcc-e	1	29-08	2	08LP
29	Biface flake	Ojcc-e	2	29-08	2	08LP
29	Flake fragment	Mbk	2	29-U-Mbk	2	08LP
29	Biface flake	Mch	1	29-U-Mch	2	08LP
29	Secondary flake	Ojcc-b	2	29-U-Ojcc-b	2-4	08LP
29	Biface flake	Ojcc-b	3	29-U-Ojcc-b	2-4	08LP
29	Flake fragment	Ojcc-b	8	29-U-Ojcc-b	2-4	08LP
29	Primary flake	Ojcc-e	2	29-U-Ojcc-e	1-4	08LP
29	Secondary flake	Ojcc-e	3	29-U-Ojcc-e	1-4	08LP
29	Biface flake	Ojcc-e	7	29-U-Ojcc-e	1-4	08LP
29	Flake fragment	Ojcc-e	15	29-U-Ojcc-e	1-4	08LP
29	Secondary flake	Ojcc-m	1	29-U-Ojcc-m	2-4	08LP
29	Biface flake	Ojcc-m	3	29-U-Ojcc-m	2-4	08LP
29	Flake fragment	Ojcc-m	13	29-U-Ojcc-m	2-4	08LP
30	Secondary flake	Mbk	1			03MLA
30	Biface flake	Mbk	1			03MLA
30	Flake fragment	Mbk	1			03MLA
31	Secondary flake	Mbk	1			03MLA
32	Flake fragment	Mbk	2	32-01	3-4	08LP
32	Primary flake	Ojcc-b	1	32-02	1	08LP
32	Secondary flake	Ojcc-b	1	32-02	1	08LP
32	Flake fragment	Ojcc-b	2	32-03	2	08LP
32	Secondary flake	Ojcc-e	3	32-04	2-4	08LP

Feature Debitage Data.

Feature	Type	Raw Material	N	Cobble	Cobble Reduction Stages	Component
32	Biface flake	Ojcc-e	16	32-04	2-4	08LP
32	Flake fragment	Ojcc-e	22	32-04	2-4	08LP
32	Secondary flake	Ojcc-m	2	32-05	1-2	08LP
32	Flake fragment	Mbk	1	32-U-Mbk	3-4	08LP
32	Primary flake	Ojcc-m	4	32-U-Ojcc-m	1-4	08LP
32	Secondary flake	Ojcc-m	1	32-U-Ojcc-m	1-4	08LP
32	Biface flake	Ojcc-m	2	32-U-Ojcc-m	1-4	08LP
32	Flake fragment	Ojcc-m	7	32-U-Ojcc-m	1-4	08LP
33	Biface flake	Mbk	3	33-01	3-4	08LP
33	Biface flake	Ojcc-b	7	33-02	2-4	08LP
33	Flake fragment	Ojcc-b	8	33-02	2-4	08LP
33	Secondary flake	Ojcc-e	3	33-03	2	08LP
33	Biface flake	Ojcc-e	1	33-03	2	08LP
33	Flake fragment	Ojcc-e	3	33-03	2	08LP
33	Primary flake	Ojcc-e	1	33-04	1-4	08LP
33	Secondary flake	Ojcc-e	1	33-04	1-4	08LP
33	Biface flake	Ojcc-e	5	33-04	1-4	08LP
33	Flake fragment	Ojcc-e	1	33-04	1-4	08LP
33	Primary flake	Ojcc-e	1	33-05	1-2	08LP
33	Secondary flake	Ojcc-e	1	33-05	1-2	08LP
33	Flake fragment	Ojcc-e	4	33-06	3-4	08LP
33	Biface flake	Ojcc-m	7	33-07	3-4	08LP
33	Flake fragment	Ojcc-m	4	33-07	3-4	08LP
33	Biface flake	Ojcc-m	1	33-08	2	08LP
33	Flake fragment	Ojcc-m	1	33-08	2	08LP
33	Biface flake	Mbk	1	33-U-Mbk	2	08LP
33	Flake fragment	Mbk	2	33-U-Mbk	2	08LP
33	Secondary flake	Mch	1	33-U-Mch	2	08LP
33	Biface flake	Mch	2	33-U-Mch	2	08LP
33	Biface flake	Ojcc-b	1	33-U-Ojcc-b	2-4	08LP
33	Flake fragment	Ojcc-b	7	33-U-Ojcc-b	2-4	08LP
33	Secondary flake	Ojcc-e	1	33-U-Ojcc-e	2-4	08LP
33	Tertiary flake	Ojcc-e	1	33-U-Ojcc-e	2-4	08LP
33	Biface flake	Ojcc-e	14	33-U-Ojcc-e	2-4	08LP
33	Flake fragment	Ojcc-e	28	33-U-Ojcc-e	2-4	08LP
33	Primary flake	Ojcc-m	1	33-U-Ojcc-m	1-4	08LP
33	Flake fragment	Ojcc-m	7	33-U-Ojcc-m	1-4	08LP
36	Secondary flake	Ojcc-e	4	36-01	2	08LP
36	Biface flake	Ojcc-e	6	36-01	2	08LP
36	Flake fragment	Ojcc-e	1	36-01	2	08LP
36	Biface flake	Ojcc-e	1	36-03	2-4	08LP
36	Flake fragment	Ojcc-e	3	36-03	2-4	08LP
36	Biface flake	Ojcc-e	2	36-04	3-4	08LP
36	Flake fragment	Ojcc-e	2	36-04	3-4	08LP
36	Biface flake	Ojcc-e	1	36-05	2-4	08LP
36	Flake fragment	Ojcc-e	2	36-05	2-4	08LP
36	Flake fragment	Ojcc-e	2	36-06	1-2	08LP
36	Flake fragment	Ojcc-e	2	36-07	2	08LP
36	Secondary flake	Mbk	1	36-08	2-4	08LP
36	Biface flake	Mbk	2	36-08	2-4	08LP
36	Flake fragment	Mbk	1	36-08	2-4	08LP
36	Biface flake	Ojcc-e	1	36-U-Ojcc-e	2-4	08LP
36	Flake fragment	Ojcc-e	2	36-U-Ojcc-e	2-4	08LP
36	Secondary flake	Mbk	1	36-U-Mbk	2	08LP
38	Secondary flake	Ojcc-e	1	38-01	2-4	08LP
38	Biface flake	Ojcc-e	6	38-01	2-4	08LP
38	Flake fragment	Ojcc-e	13	38-01	2-4	08LP
38	Primary flake	Ojcc-e	2	38-02	1-2	08LP
38	Secondary flake	Ojcc-e	3	38-02	1-2	08LP
38	Biface flake	Ojcc-e	2	38-02	1-2	08LP
38	Flake fragment	Ojcc-e	4	38-02	1-2	08LP

Feature Debitage Data.

Feature	Type	Raw Material	N	Cobble	Cobble Reduction Stages	Component
38	Secondary flake	Ojcc-e	1	38-03	2	08LP
38	Biface flake	Ojcc-e	7	38-03	2	08LP
38	Flake fragment	Ojcc-e	5	38-03	2	08LP
38	Tertiary flake	Ojcc-e	1	38-04	2	08LP
38	Biface flake	Ojcc-e	3	38-04	2	08LP
38	Flake fragment	Ojcc-e	3	38-04	2	08LP
38	Biface flake	Ojcc-e	1	38-05	2-4	08LP
38	Flake fragment	Ojcc-e	7	38-05	2-4	08LP
38	Flake fragment	Ojcc-e	5	38-06	2	08LP
38	Biface flake	Ojcc-e	3	38-07	2	08LP
38	Flake fragment	Ojcc-e	2	38-07	2	08LP
38	Biface flake	Ojcc-e	1	38-08	2	08LP
38	Flake fragment	Ojcc-e	4	38-08	2	08LP
38	Biface flake	Ojcc-e	3	38-09	1-2	08LP
38	Flake fragment	Ojcc-e	1	38-09	1-2	08LP
38	Biface flake	Ojcc-e	3	38-10	2-4	08LP
38	Flake fragment	Ojcc-e	3	38-10	2-4	08LP
38	Biface flake	Ojcc-e	2	38-11	1-2	08LP
38	Biface flake	Ojcc-e	2	38-12	2-4	08LP
38	Biface flake	Ojcc-e	1	38-13	2	08LP
38	Flake fragment	Ojcc-e	1	38-13	2	08LP
38	Biface flake	Ojcc-e	2	38-14	2-4	08LP
38	Flake fragment	Ojcc-e	2	38-15	2-4	08LP
38	Secondary flake	Ojcc-e	7	38-U-Ojcc-e	2-4	08LP
38	Biface flake	Ojcc-e	21	38-U-Ojcc-e	2-4	08LP
38	Flake fragment	Ojcc-e	68	38-U-Ojcc-e	2-4	08LP
38	Primary flake	Ojcc-m	1	38-U-Ojcc-m	1-2	08LP
38	Flake fragment	Ojcc-m	1	38-U-Ojcc-m	1-2	08LP
38	Flake fragment	Ojcc-b	3	29-01	2-4	08LP
38	Primary flake	Ojcc-e	1	29-04	1-2	08LP
38	Secondary flake	Ojcc-e	1	29-U-Ojcc-e	1-4	08LP
40	Secondary flake	Mch	9	40-01	2-3	08LP
40	Tertiary flake	Mch	4	40-01	2-3	08LP
40	Biface flake	Mch	92	40-01	2-3	08LP
40	Flake fragment	Mch	173	40-01	2-3	08LP
41	Primary flake	Ojcc-e	5	41-01	1	08LP
41	Secondary flake	Ojcc-e	6	41-01	1	08LP
41	Tertiary flake	Ojcc-e	3	41-01	1	08LP
41	Biface flake	Ojcc-e	1	41-01	1	08LP
41	Flake fragment	Ojcc-e	18	41-01	1	08LP
42	Primary flake	Ojcc-e	5	42-01	1-2	08LP
42	Secondary flake	Ojcc-e	7	42-01	1-2	08LP
42	Tertiary flake	Ojcc-e	1	42-01	1-2	08LP
42	Biface flake	Ojcc-e	3	42-01	1-2	08LP
42	Flake fragment	Ojcc-e	36	42-01	1-2	08LP
42	Biface flake	Ojcc-e	22	42-02	2-3	08LP
42	Flake fragment	Ojcc-e	26	42-02	2-3	08LP
42	Biface flake	Ojcc-b	15	42-03	2-3	08LP
42	Flake fragment	Ojcc-b	10	42-03	2-3	08LP
43	Tertiary flake	Ojcc-e	1	43-01	2-3	08LP
43	Biface flake	Ojcc-e	21	43-01	2-3	08LP
43	Flake fragment	Ojcc-e	36	43-01	2-3	08LP
44	Primary flake	Ojcc-e	5	44-01	2-3	08LP
44	Secondary flake	Ojcc-e	5	44-01	2-3	08LP
44	Tertiary flake	Ojcc-e	1	44-01	2-3	08LP
44	Biface flake	Ojcc-e	25	44-01	2-3	08LP
44	Flake fragment	Ojcc-e	30	44-01	2-3	08LP
45	Biface flake	Ojcc-e	3	45-01	2	08LP
45	Flake fragment	Ojcc-e	3	45-01	2	08LP
45	Biface flake	Ojcc-b	3	45-02	2	08LP
45	Flake fragment	Ojcc-b	2	45-02	2	08LP
45	Biface flake	Ojcc-b	3	45-03	2	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
ATS-1.0-1.3	Working core	Mbk	2	04ELA	ATS-1.5-1.6	Tested cobble	Pw-bk	1	04ELA
ATS-1.5-1.6	Flake fragment	Mbk	1	04ELA	ATS-1.6-1.7	Secondary flake	Mbk	2	04ELA
ATS-1.6-1.7	Biface flake	Mbk	7	04ELA	ATS-1.6-1.7	Flake fragment	Mbk	7	04ELA
ATS-1.6-1.7	Working core	Ojcc-b	1	04ELA	ATS-1.6-1.7	Flake fragment	Ojcc-b	1	04ELA
ATS-1.7-2.1	Tested cobble	Mbk	2	03MLA	ATS-1.7-2.1	Working core	Mbk	1	03MLA
ATS-1.7-2.1	Primary flake	Mbk	1	03MLA	ATS-1.7-2.1	Secondary flake	Mbk	9	03MLA
ATS-1.7-2.1	Biface flake	Mbk	10	03MLA	ATS-1.7-2.1	Flake fragment	Mbk	9	03MLA
ATS-1.7-2.1	Secondary flake	Ojcc-e	1	03MLA	ATS-2.1-2.4	Working core	Mbk	1	03MLA
ATS-2.1-2.4	Primary flake	Mbk	3	03MLA	ATS-2.1-2.4	Secondary flake	Mbk	14	03MLA
ATS-2.1-2.4	Tertiary flake	Mbk	1	03MLA	ATS-2.1-2.4	Biface flake	Mbk	7	03MLA
ATS-2.1-2.4	Flake fragment	Mbk	15	03MLA	ATS-2.1-2.4	Primary flake	Ojcc-e	1	03MLA
ATS-2.1-2.4	Exhausted core	Ojcc-b	1	03MLA	ATS-2.1-2.4	Secondary flake	Ojcc-b	1	03MLA
ATS-2.3-2.4	Primary flake	Mbk	5	03MLA	ATS-2.3-2.4	Secondary flake	Mbk	21	03MLA
ATS-2.3-2.4	Tertiary flake	Mbk	4	03MLA	ATS-2.3-2.4	Biface flake	Mbk	40	03MLA
ATS-2.3-2.4	Flake fragment	Mbk	59	03MLA	ATS-2.3-2.4	Flake fragment	Mch	2	03MLA
ATS-2.3-2.4	Biface flake	Ojcc-e	1	03MLA	ATS-2.3-2.4	Primary flake	Ojcc-b	1	03MLA
ATS-2.3-2.4	Flake fragment	Ojcc-b	1	03MLA	ATS-2.3-2.4	Biface flake	Ojcc-m	1	03MLA
ATS-2.3-2.4	Flake fragment	Ojcc-m	1	03MLA	ATS-2.3-2.4	Biface flake	Ojcc-o	1	03MLA
ATS-2.3-2.4	Primary flake	Pw-ch	1	03MLA	BTS-1.3-1.5	Biface flake	Mbk	2	05MA
BTS-1.3-1.5	Flake fragment	Mbk	1	05MA	BTS-1.3-1.5	Secondary flake	Ojcc-b	1	05MA
BTS-1.5-1.8	Biface flake	Mbk	2	05MA	BTS-1.5-1.8	Flake fragment	Mbk	2	05MA
BTS-1.5-1.8	Secondary flake	Ojcc-m	1	05MA	BTS-1.8-2.0	Primary flake	Mbk	1	06LEA
BTS-1.8-2.0	Secondary flake	Mbk	2	06LEA	BTS-1.8-2.0	Primary flake	Mch	1	06LEA
BTS-1.8-2.0	Secondary flake	Mch	2	06LEA	BTS-1.8-2.0	Primary flake	Ojcc-o	1	06LEA
BTS-2.0-2.4	Exhausted core	Mbk	1	06LEA	BTS-2.0-2.4	Secondary flake	Mbk	4	06LEA
BTS-2.0-2.4	Secondary flake	Mch	1	06LEA	BTS-2.0-2.4	Biface flake	Mch	1	06LEA
BTS-2.0-2.4	Flake fragment	Ojcc-b	1	06LEA	BTS-2.0-2.4	Biface flake	Ojcc-e	1	06LEA
BTS-2.4-2.6	Working core	Mbk	1	07EEA	BTS-2.4-2.6	Biface flake	Mbk	1	07EEA
BTS-2.4-2.6	Secondary flake	Mch	1	07EEA	BTS-2.4-2.6	Flake fragment	Mch	1	07EEA
BTS-2.4-2.6	Primary flake	Ojcc-e	1	07EEA	BTS-2.4-2.6	Flake fragment	Ojcc-e	3	07EEA
BTS-2.4-2.6	Tertiary flake	Ojcc-b	2	07EEA	BTS-2.4-2.6	Biface flake	Ojcc-b	1	07EEA
BTS-2.4-2.6	Flake fragment	Ojcc-b	1	07EEA	BTS-2.4-2.6	Biface flake	Ojcc-o	1	07EEA
BTS-2.6	Flake fragment	Mbk	3	07EEA	BTS-2.6	Flake fragment	Mch	2	07EEA
BTS-2.6	Primary flake	Ojcc-e	3	07EEA	BTS-2.6	Flake fragment	Ojcc-e	4	07EEA
BTS-2.6	Biface flake	Ojcc-b	1	07EEA	BTS-2.6	Flake fragment	Ojcc-b	2	07EEA
BTS-2.6	Biface flake	Ojcc-m	1	07EEA	BTS-2.6	Flake fragment	Ojcc-m	1	07EEA
ER-S/18	Exhausted core	Mbk	1		ER-S/19	Tested cobble	Ojcc-e	1	
ER-S/20	Tested cobble	Mbk	1		F-01	Flake fragment	Mbk	4	01WM
F-01	Biface flake	Ojcc-m	1	01WM	F-01	Flake fragment	Ojcc-e	1	01WM
F-01	Secondary flake	Mch	1	01WM	F-06	Tertiary flake	Mbk	2	01WM
F-06	Flake fragment	Mbk	2	01WM	F-07	Biface flake	Mbk	1	01WM
F-07	Flake fragment	Mbk	3	01WM	F-12	Flake fragment	Mbk	1	01WM
F-15	Tertiary flake	Ojcc-e	1	01WM	F-15	Biface flake	Ojcc-e	2	01WM
F-15	Flake fragment	Ojcc-e	1	01WM	F-16	Tertiary flake	Mbk	1	01WM
F-16	Flake fragment	Mbk	1	01WM	F-17	Flake fragment	Mbk	1	04ELA
F-18	Tertiary flake	Mbk	1	03MLA	F-18	Tertiary flake	Ojcc-e	1	03MLA
F-18	Flake fragment	Ojcc-e	1	03MLA	F-20	Secondary flake	Mbk	1	03MLA
F-20	Tertiary flake	Mbk	2	03MLA	F-20	Biface flake	Mbk	2	03MLA
F-20	Flake fragment	Mbk	4	03MLA	F-22	Biface flake	Mbk	1	03MLA
F-23	Secondary flake	Ojcc-e	2	08LP	F-23	Tertiary flake	Ojcc-e	1	08LP
F-23	Biface flake	Ojcc-e	7	08LP	F-23	Flake fragment	Ojcc-e	4	08LP
F-23	Primary flake	Ojcc-e	5	08LP	F-23	Secondary flake	Ojcc-e	1	08LP
F-23	Biface flake	Ojcc-e	5	08LP	F-23	Flake fragment	Ojcc-e	8	08LP
F-23	Secondary flake	Ojcc-e	2	08LP	F-23	Biface flake	Ojcc-e	1	08LP
F-23	Flake fragment	Ojcc-e	2	08LP	F-23	Secondary flake	Ojcc-e	2	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
F-23	Biface flake	Ojcc-e	1	08LP	F-23	Flake fragment	Ojcc-e	2	08LP
F-23	Flake fragment	Ojcc-e	3	08LP	F-24	Primary flake	Ojcc-e	2	08LP
F-24	Secondary flake	Ojcc-e	2	08LP	F-24	Tertiary flake	Ojcc-e	1	08LP
F-24	Biface flake	Ojcc-e	5	08LP	F-24	Flake fragment	Ojcc-e	14	08LP
F-24	Primary flake	Ojcc-e	5	08LP	F-24	Secondary flake	Ojcc-e	3	08LP
F-24	Biface flake	Ojcc-e	53	08LP	F-24	Flake fragment	Ojcc-e	31	08LP
F-26	Biface flake	Mch	1	08LP	F-26	Flake fragment	Mch	3	08LP
F-26	Flake fragment	Mch	3	08LP	F-26	Primary flake	Ojcc-e	1	08LP
F-26	Secondary flake	Ojcc-e	2	08LP	F-26	Tertiary flake	Ojcc-e	2	08LP
F-26	Biface flake	Ojcc-e	3	08LP	F-26	Flake fragment	Ojcc-e	17	08LP
F-26	Tertiary flake	Ojcc-e	2	08LP	F-26	Biface flake	Ojcc-e	2	08LP
F-26	Flake fragment	Ojcc-e	5	08LP	F-26	Secondary flake	Ojcc-e	3	08LP
F-26	Biface flake	Ojcc-e	1	08LP	F-26	Flake fragment	Ojcc-e	3	08LP
F-26	Biface flake	Ojcc-e	1	08LP	F-26	Flake fragment	Ojcc-e	3	08LP
F-26	Biface flake	Ojcc-e	2	08LP	F-26	Flake fragment	Ojcc-e	3	08LP
F-26	Primary flake	Ojcc-e	1	08LP	F-26	Secondary flake	Ojcc-e	1	08LP
F-26	Flake fragment	Ojcc-e	1	08LP	F-26	Primary flake	Ojcc-b	1	08LP
F-26	Secondary flake	Ojcc-b	1	08LP	F-26	Biface flake	Ojcc-b	2	08LP
F-26	Flake fragment	Ojcc-b	3	08LP	F-26	Secondary flake	Ojcc-b	1	08LP
F-26	Biface flake	Ojcc-b	2	08LP	F-26	Flake fragment	Ojcc-b	4	08LP
F-26	Biface flake	Ojcc-b	1	08LP	F-26	Flake fragment	Ojcc-b	2	08LP
F-26	Biface flake	Ojcc-e	4	08LP	F-26	Flake fragment	Ojcc-e	11	08LP
F-26	Flake fragment	Ojcc-b	2	08LP	F-27	Secondary flake	Ojcc-e	1	08LP
F-27	Biface flake	Ojcc-e	3	08LP	F-27	Flake fragment	Ojcc-e	3	08LP
F-27	Biface flake	Ojcc-e	7	08LP	F-27	Flake fragment	Ojcc-e	7	08LP
F-28	Tertiary flake	Mbk	1	08LP	F-28	Biface flake	Mbk	7	08LP
F-28	Flake fragment	Mbk	5	08LP	F-28	Secondary flake	Mbk	2	08LP
F-28	Biface flake	Mbk	10	08LP	F-28	Flake fragment	Mbk	8	08LP
F-28	Secondary flake	Mbk	3	08LP	F-28	Biface flake	Mbk	11	08LP
F-28	Flake fragment	Mbk	1	08LP	F-28	Primary flake	Mbk	2	08LP
F-28	Secondary flake	Mbk	6	08LP	F-28	Biface flake	Mbk	12	08LP
F-28	Flake fragment	Mbk	13	08LP	F-28	Tertiary flake	Mch	2	08LP
F-28	Biface flake	Mch	2	08LP	F-28	Flake fragment	Mch	1	08LP
F-28	Biface flake	Mch	8	08LP	F-28	Flake fragment	Mch	3	08LP
F-28	Secondary flake	Mch	1	08LP	F-28	Flake fragment	Mch	1	08LP
F-28	Biface flake	Mch	24	08LP	F-28	Flake fragment	Mch	29	08LP
F-28	Primary flake	Mch	1	08LP	F-28	Secondary flake	Mch	2	08LP
F-28	Tertiary flake	Mch	2	08LP	F-28	Biface flake	Mch	50	08LP
F-28	Flake fragment	Mch	49	08LP	F-28	Biface flake	Ojcc-b	4	08LP
F-28	Flake fragment	Ojcc-b	8	08LP	F-28	Primary flake	Ojcc-b	1	08LP
F-28	Secondary flake	Ojcc-b	1	08LP	F-28	Biface flake	Ojcc-b	4	08LP
F-28	Flake fragment	Ojcc-b	2	08LP	F-28	Biface flake	Ojcc-b	3	08LP
F-28	Flake fragment	Ojcc-b	1	08LP	F-28	Biface flake	Ojcc-b	3	08LP
F-28	Flake fragment	Ojcc-b	2	08LP	F-28	Biface flake	Ojcc-b	2	08LP
F-28	Secondary flake	Ojcc-b	1	08LP	F-28	Flake fragment	Ojcc-b	1	08LP
F-28	Flake fragment	Ojcc-b	2	08LP	F-28	Biface flake	Ojcc-b	1	08LP
F-28	Flake fragment	Ojcc-b	1	08LP	F-28	Secondary flake	Ojcc-b	2	08LP
F-28	Flake fragment	Ojcc-b	2	08LP	F-28	Biface flake	Ojcc-b	1	08LP
F-28	Flake fragment	Ojcc-b	1	08LP	F-28	Primary flake	Ojcc-b	1	08LP
F-28	Flake fragment	Ojcc-b	1	08LP	F-28	Tertiary flake	Ojcc-b	1	08LP
F-28	Flake fragment	Ojcc-b	1	08LP	F-28	Primary flake	Ojcc-b	3	08LP
F-28	Secondary flake	Ojcc-b	19	08LP	F-28	Tertiary flake	Ojcc-b	9	08LP
F-28	Biface flake	Ojcc-b	195	08LP	F-28	Flake fragment	Ojcc-b	266	08LP
F-28	Biface flake	Ojcc-e	4	08LP	F-28	Biface flake	Ojcc-e	1	08LP
F-28	Flake fragment	Ojcc-e	1	08LP	F-28	Biface flake	Ojcc-e	1	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
F-28	Flake fragment	Ojcc-e	1	08LP	F-28	Secondary flake	Ojcc-e	2	08LP
F-28	Secondary flake	Ojcc-e	2	08LP	F-28	Tertiary flake	Ojcc-e	1	08LP
F-28	Biface flake	Ojcc-e	1	08LP	F-28	Flake fragment	Ojcc-e	2	08LP
F-28	Biface flake	Ojcc-e	4	08LP	F-28	Flake fragment	Ojcc-e	3	08LP
F-28	Biface flake	Ojcc-e	1	08LP	F-28	Flake fragment	Ojcc-e	1	08LP
F-28	Biface flake	Ojcc-e	31	08LP	F-28	Flake fragment	Ojcc-e	31	08LP
F-28	Biface flake	Ojcc-e	2	08LP	F-28	Primary flake	Ojcc-e	1	08LP
F-28	Secondary flake	Ojcc-e	2	08LP	F-28	Biface flake	Ojcc-e	7	08LP
F-28	Flake fragment	Ojcc-e	4	08LP	F-28	Secondary flake	Ojcc-e	3	08LP
F-28	Tertiary flake	Ojcc-e	1	08LP	F-28	Biface flake	Ojcc-e	2	08LP
F-28	Secondary flake	Ojcc-e	1	08LP	F-28	Flake fragment	Ojcc-e	1	08LP
F-28	Secondary flake	Ojcc-e	2	08LP	F-28	Flake fragment	Ojcc-e	1	08LP
F-28	Biface flake	Ojcc-e	1	08LP	F-28	Flake fragment	Ojcc-e	1	08LP
F-28	Primary flake	Ojcc-e	2	08LP	F-28	Secondary flake	Ojcc-e	2	08LP
F-28	Biface flake	Ojcc-e	1	08LP	F-28	Flake fragment	Ojcc-e	1	08LP
F-28	Flake fragment	Ojcc-e	3	08LP	F-28	Secondary flake	Ojcc-e	2	08LP
F-28	Flake fragment	Ojcc-e	1	08LP	F-28	Primary flake	Ojcc-e	11	08LP
F-28	Secondary flake	Ojcc-e	27	08LP	F-28	Tertiary flake	Ojcc-e	2	08LP
F-28	Biface flake	Ojcc-e	100	08LP	F-28	Flake fragment	Ojcc-e	139	08LP
F-28	Primary flake	Ojcc-m	1	08LP	F-28	Flake fragment	Ojcc-m	1	08LP
F-28	Secondary flake	Ojcc-m	2	08LP	F-28	Tertiary flake	Ojcc-m	1	08LP
F-28	Biface flake	Ojcc-m	3	08LP	F-28	Flake fragment	Ojcc-m	6	08LP
F-28	Secondary flake	Ojcc-m	2	08LP	F-28	Biface flake	Ojcc-m	12	08LP
F-28	Flake fragment	Ojcc-m	18	08LP	F-28	Biface flake	Ojcc-m	2	08LP
F-28	Flake fragment	Ojcc-m	1	08LP	F-28	Tertiary flake	Ojcc-m	1	08LP
F-28	Biface flake	Ojcc-m	1	08LP	F-28	Secondary flake	Ojcc-m	2	08LP
F-28	Tertiary flake	Ojcc-m	5	08LP	F-28	Biface flake	Ojcc-m	32	08LP
F-28	Flake fragment	Ojcc-m	82	08LP	F-28	Biface flake	Ojcc-o	2	08LP
F-28	Flake fragment	Ojcc-o	2	08LP	F-28	Primary flake	Ojcc-q	1	08LP
F-28	Secondary flake	Ojcc-b	2	08LP	F-28	Biface flake	Ojcc-b	3	08LP
F-28	Flake fragment	Ojcc-b	3	08LP	F-29	Secondary flake	Ojcc-b	1	08LP
F-29	Biface flake	Ojcc-b	6	08LP	F-29	Flake fragment	Ojcc-b	11	08LP
F-29	Secondary flake	Ojcc-b	3	08LP	F-29	Biface flake	Ojcc-b	4	08LP
F-29	Flake fragment	Ojcc-b	9	08LP	F-29	Primary flake	Ojcc-b	1	08LP
F-29	Biface flake	Ojcc-b	1	08LP	F-29	Secondary flake	Ojcc-e	1	08LP
F-29	Flake fragment	Ojcc-e	2	08LP	F-29	Biface flake	Ojcc-e	2	08LP
F-29	Biface flake	Ojcc-e	2	08LP	F-29	Biface flake	Ojcc-e	1	08LP
F-29	Flake fragment	Ojcc-e	1	08LP	F-29	Secondary flake	Ojcc-e	1	08LP
F-29	Biface flake	Ojcc-e	2	08LP	F-29	Flake fragment	Mbk	2	08LP
F-29	Biface flake	Mch	1	08LP	F-29	Secondary flake	Ojcc-b	2	08LP
F-29	Biface flake	Ojcc-b	3	08LP	F-29	Flake fragment	Ojcc-b	8	08LP
F-29	Primary flake	Ojcc-e	2	08LP	F-29	Secondary flake	Ojcc-e	3	08LP
F-29	Biface flake	Ojcc-e	7	08LP	F-29	Flake fragment	Ojcc-e	15	08LP
F-29	Secondary flake	Ojcc-m	1	08LP	F-29	Biface flake	Ojcc-m	3	08LP
F-29	Flake fragment	Ojcc-m	13	08LP	F-30	Secondary flake	Mbk	1	03MLA
F-30	Biface flake	Mbk	1	03MLA	F-30	Flake fragment	Mbk	1	03MLA
F-31	Secondary flake	Mbk	1	03MLA	F-32	Flake fragment	Mbk	2	08LP
F-32	Primary flake	Ojcc-b	1	08LP	F-32	Secondary flake	Ojcc-b	1	08LP
F-32	Flake fragment	Ojcc-b	2	08LP	F-32	Secondary flake	Ojcc-e	3	08LP
F-32	Biface flake	Ojcc-e	16	08LP	F-32	Flake fragment	Ojcc-e	22	08LP
F-32	Secondary flake	Ojcc-m	2	08LP	F-32	Flake fragment	Mbk	1	08LP
F-32	Primary flake	Ojcc-m	4	08LP	F-32	Secondary flake	Ojcc-m	1	08LP
F-32	Biface flake	Ojcc-m	2	08LP	F-32	Flake fragment	Ojcc-m	7	08LP
F-33	Biface flake	Mbk	3	08LP	F-33	Biface flake	Ojcc-b	7	08LP
F-33	Flake fragment	Ojcc-b	8	08LP	F-33	Secondary flake	Ojcc-e	3	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
F-33	Biface flake	Ojcc-e	1	08LP	F-33	Flake fragment	Ojcc-e	3	08LP
F-33	Primary flake	Ojcc-e	1	08LP	F-33	Secondary flake	Ojcc-e	1	08LP
F-33	Biface flake	Ojcc-e	5	08LP	F-33	Flake fragment	Ojcc-e	1	08LP
F-33	Primary flake	Ojcc-e	1	08LP	F-33	Secondary flake	Ojcc-e	1	08LP
F-33	Flake fragment	Ojcc-e	4	08LP	F-33	Biface flake	Ojcc-m	7	08LP
F-33	Flake fragment	Ojcc-m	4	08LP	F-33	Biface flake	Ojcc-m	1	08LP
F-33	Flake fragment	Ojcc-m	1	08LP	F-33	Biface flake	Mbk	1	08LP
F-33	Flake fragment	Mbk	2	08LP	F-33	Secondary flake	Mch	1	08LP
F-33	Biface flake	Mch	2	08LP	F-33	Biface flake	Ojcc-b	1	08LP
F-33	Flake fragment	Ojcc-b	7	08LP	F-33	Secondary flake	Ojcc-e	1	08LP
F-33	Tertiary flake	Ojcc-e	1	08LP	F-33	Biface flake	Ojcc-e	14	08LP
F-33	Flake fragment	Ojcc-e	28	08LP	F-33	Primary flake	Ojcc-m	1	08LP
F-33	Flake fragment	Ojcc-m	7	08LP	F-36	Secondary flake	Ojcc-e	4	08LP
F-36	Biface flake	Ojcc-e	6	08LP	F-36	Flake fragment	Ojcc-e	1	08LP
F-36	Biface flake	Ojcc-e	1	08LP	F-36	Flake fragment	Ojcc-e	3	08LP
F-36	Biface flake	Ojcc-e	2	08LP	F-36	Flake fragment	Ojcc-e	2	08LP
F-36	Biface flake	Ojcc-e	1	08LP	F-36	Flake fragment	Ojcc-e	2	08LP
F-36	Flake fragment	Ojcc-e	2	08LP	F-36	Flake fragment	Ojcc-e	2	08LP
F-36	Secondary flake	Mbk	1	08LP	F-36	Biface flake	Mbk	2	08LP
F-36	Flake fragment	Mbk	1	08LP	F-36	Biface flake	Ojcc-e	1	08LP
F-36	Flake fragment	Ojcc-e	2	08LP	F-36	Secondary flake	Mbk	1	08LP
F-38	Secondary flake	Ojcc-e	1	08LP	F-38	Biface flake	Ojcc-e	6	08LP
F-38	Flake fragment	Ojcc-e	13	08LP	F-38	Primary flake	Ojcc-e	2	08LP
F-38	Secondary flake	Ojcc-e	3	08LP	F-38	Biface flake	Ojcc-e	2	08LP
F-38	Flake fragment	Ojcc-e	4	08LP	F-38	Secondary flake	Ojcc-e	1	08LP
F-38	Biface flake	Ojcc-e	7	08LP	F-38	Flake fragment	Ojcc-e	5	08LP
F-38	Tertiary flake	Ojcc-e	1	08LP	F-38	Biface flake	Ojcc-e	3	08LP
F-38	Flake fragment	Ojcc-e	3	08LP	F-38	Biface flake	Ojcc-e	1	08LP
F-38	Flake fragment	Ojcc-e	7	08LP	F-38	Flake fragment	Ojcc-e	5	08LP
F-38	Biface flake	Ojcc-e	3	08LP	F-38	Flake fragment	Ojcc-e	2	08LP
F-38	Biface flake	Ojcc-e	1	08LP	F-38	Flake fragment	Ojcc-e	4	08LP
F-38	Biface flake	Ojcc-e	3	08LP	F-38	Flake fragment	Ojcc-e	1	08LP
F-38	Biface flake	Ojcc-e	3	08LP	F-38	Flake fragment	Ojcc-e	3	08LP
F-38	Biface flake	Ojcc-e	2	08LP	F-38	Biface flake	Ojcc-e	2	08LP
F-38	Biface flake	Ojcc-e	1	08LP	F-38	Flake fragment	Ojcc-e	1	08LP
F-38	Biface flake	Ojcc-e	2	08LP	F-38	Flake fragment	Ojcc-e	2	08LP
F-38	Secondary flake	Ojcc-e	7	08LP	F-38	Biface flake	Ojcc-e	21	08LP
F-38	Flake fragment	Ojcc-e	68	08LP	F-38	Primary flake	Ojcc-m	1	08LP
F-38	Flake fragment	Ojcc-m	1	08LP	F-38	Flake fragment	Ojcc-b	3	08LP
F-38	Primary flake	Ojcc-e	1	08LP	F-38	Secondary flake	Ojcc-e	1	08LP
F-40	Secondary flake	Mch	9	08LP	F-40	Tertiary flake	Mch	4	08LP
F-40	Biface flake	Mch	92	08LP	F-40	Flake fragment	Mch	173	08LP
F-41	Primary flake	Ojcc-e	5	08LP	F-41	Secondary flake	Ojcc-e	6	08LP
F-41	Tertiary flake	Ojcc-e	3	08LP	F-41	Biface flake	Ojcc-e	1	08LP
F-41	Flake fragment	Ojcc-e	18	08LP	F-42	Primary flake	Ojcc-e	5	08LP
F-42	Secondary flake	Ojcc-e	7	08LP	F-42	Tertiary flake	Ojcc-e	1	08LP
F-42	Biface flake	Ojcc-e	3	08LP	F-42	Flake fragment	Ojcc-e	36	08LP
F-42	Biface flake	Ojcc-e	22	08LP	F-42	Flake fragment	Ojcc-e	26	08LP
F-42	Biface flake	Ojcc-b	15	08LP	F-42	Flake fragment	Ojcc-b	10	08LP
F-43	Tertiary flake	Ojcc-e	1	08LP	F-43	Biface flake	Ojcc-e	21	08LP
F-43	Flake fragment	Ojcc-e	36	08LP	F-44	Primary flake	Ojcc-e	5	08LP
F-44	Secondary flake	Ojcc-e	5	08LP	F-44	Tertiary flake	Ojcc-e	1	08LP
F-44	Biface flake	Ojcc-e	25	08LP	F-44	Flake fragment	Ojcc-e	30	08LP
F-45	Biface flake	Ojcc-e	3	08LP	F-45	Flake fragment	Ojcc-e	3	08LP
F-45	Biface flake	Ojcc-b	3	08LP	F-45	Flake fragment	Ojcc-b	2	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
F-45	Biface flake	Ojcc-b	3	08LP	PZBD	Working core	Mbk	1	01WM
PZBD	Primary flake	Mbk	5	01WM	PZBD	Secondary flake	Mbk	10	01WM
PZBD	Tertiary flake	Mbk	8	01WM	PZBD	Biface flake	Mbk	10	01WM
PZBD	Flake fragment	Mbk	20	01WM	PZBD	Working core	Mch	1	01WM
PZBD	Biface flake	Mch	1	01WM	PZBD	Flake fragment	Mch	1	01WM
PZBD	Primary flake	Ojcc-e	3	01WM	PZBD	Secondary flake	Ojcc-e	2	01WM
PZBD	Biface flake	Ojcc-e	3	01WM	PZBD	Flake fragment	Ojcc-e	1	01WM
PZBD	Secondary flake	Ojcc-b	1	01WM	PZBD	Biface flake	Ojcc-b	1	01WM
PZBD	Flake fragment	Ojcc-m	1	01WM	T-1b/T-1c	Tested cobble	Pw-bk	1	022WLA
T-1b/T-1c	Primary flake	Pw-bk	1	022WLA	T-1b/T-1c	Secondary flake	Mbk	7	022WLA
T-1b/T-1c	Tertiary flake	Mbk	7	022WLA	T-1b/T-1c	Biface flake	Mbk	20	022WLA
T-1b/T-1c	Flake fragment	Mbk	30	022WLA	T-1b/T-1c	Biface flake	Mch	3	022WLA
T-1b/T-1c	Secondary flake	Ojcc-e	2	022WLA	T-1b/T-1c	Tertiary flake	Ojcc-e	2	022WLA
T-1b/T-1c	Biface flake	Ojcc-e	1	022WLA	T-1b/T-1c	Flake fragment	Ojcc-e	6	022WLA
T-1b/T-1c	Biface flake	Ojcc-b	4	022WLA	T-1b/T-1c	Flake fragment	Ojcc-b	4	022WLA
T-1b/T-1c	Flake fragment	Ojcc-m	3	022WLA	T-1b/T-1c	Flake fragment	Ojcc-o	1	022WLA
TU-01-3	Biface flake	Ojcc-e	1	021W	TU-01-4	Flake fragment	Ojcc-o	1	021W
TU-01-6	Biface flake	Mbk	1	021W	TU-01-6	Flake fragment	Mbk	1	021W
TU-01-6	Flake fragment	Ojcc-m	1	021W	TU-01-7	Secondary flake	Mch	1	021W
TU-01-7	Flake fragment	Ojcc-e	1	021W	TU-01-8	Flake fragment	Mbk	1	021W
TU-02-11	Tertiary flake	Mbk	2	04ELA	TU-02-11	Flake fragment	Mbk	2	04ELA
TU-02-11	Biface flake	Ojcc-m	3	04ELA	TU-02-12	Biface flake	Mbk	2	04ELA
TU-02-13	Biface flake	Mbk	2	04ELA	TU-02-13	Biface flake	Ojcc-o	1	04ELA
TU-02-14	Flake fragment	Mbk	2	04ELA	TU-02-15	Flake fragment	Mbk	2	04ELA
TU-03-18	Biface flake	Mbk	1	06LEA	TU-03-18	Flake fragment	Mbk	1	06LEA
TU-03-19	Primary flake	Mbk	1	06LEA	TU-03-19	Biface flake	Mbk	1	06LEA
TU-03-21	Biface flake	Mbk	1	06LEA	TU-03-22	Secondary flake	Mbk	1	06LEA
TU-03-23	Flake fragment	Mch	1	06LEA	TU-03-23	Flake fragment	Ojcc-b	1	06LEA
TU-04-26	Biface flake	Mbk	2	07EEA	TU-04-26	Flake fragment	Mbk	3	07EEA
TU-04-26	Biface flake	Mch	2	07EEA	TU-04-26	Flake fragment	Mch	2	07EEA
TU-04-26	Flake fragment	Ojcc-m	4	07EEA	TU-04-26	Biface flake	Ojcc-b	2	07EEA
TU-04-26	Flake fragment	Ojcc-b	3	07EEA	TU-04-26	Flake fragment	Ojcc-e	5	07EEA
TU-04-27	Secondary flake	Mch	1	07EEA	TU-04-27	Biface flake	Mch	1	07EEA
TU-04-27	Flake fragment	Mch	4	07EEA	TU-04-27	Flake fragment	Ojcc-m	2	07EEA
TU-04-27	Secondary flake	Ojcc-b	2	07EEA	TU-04-27	Biface flake	Ojcc-b	4	07EEA
TU-04-27	Flake fragment	Ojcc-b	5	07EEA	TU-04-27	Flake fragment	Ojcc-o	5	07EEA
TU-04-27	Secondary flake	Ojcc-e	1	07EEA	TU-04-27	Biface flake	Ojcc-e	3	07EEA
TU-04-27	Flake fragment	Ojcc-e	4	07EEA	TU-04-28	Biface flake	Mbk	1	07EEA
TU-04-28	Flake fragment	Mbk	3	07EEA	TU-04-28	Flake fragment	Mch	3	07EEA
TU-04-28	Tertiary flake	Ojcc-m	1	07EEA	TU-04-28	Biface flake	Ojcc-m	3	07EEA
TU-04-28	Flake fragment	Ojcc-m	6	07EEA	TU-04-28	Secondary flake	Ojcc-b	1	07EEA
TU-04-28	Tertiary flake	Ojcc-b	1	07EEA	TU-04-28	Biface flake	Ojcc-b	2	07EEA
TU-04-28	Flake fragment	Ojcc-b	2	07EEA	TU-04-28	Biface flake	Ojcc-e	1	07EEA
TU-04-28	Flake fragment	Ojcc-e	10	07EEA	TU-04-28	Biface flake	Ojcc-q	1	07EEA
TU-04-29	Biface flake	Mbk	3		TU-04-29	Flake fragment	Mbk	8	
TU-04-29	Biface flake	Mrs-l	1		TU-04-29	Biface flake	Mch	1	
TU-04-29	Flake fragment	Mch	1		TU-04-29	Secondary flake	Ojcc-e	2	
TU-04-29	Tertiary flake	Ojcc-e	2		TU-04-29	Biface flake	Ojcc-e	2	
TU-04-29	Flake fragment	Ojcc-e	16		TU-04-29	Secondary flake	Ojcc-b	4	
TU-04-29	Tertiary flake	Ojcc-b	2		TU-04-29	Biface flake	Ojcc-b	12	
TU-04-29	Flake fragment	Ojcc-b	27		TU-04-29	Secondary flake	Ojcc-m	1	
TU-04-29	Flake fragment	Ojcc-m	2		TU-04-29	Primary flake	Ojcc-c	1	
TU-04-30	Secondary flake	Mbk	1	08LP	TU-04-30	Biface flake	Mbk	1	08LP
TU-04-30	Flake fragment	Mbk	8	08LP	TU-04-30	Flake fragment	Mch	5	08LP
TU-04-30	Primary flake	Ojcc-e	4	08LP	TU-04-30	Secondary flake	Ojcc-e	4	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-04-30	Tertiary flake	Ojcc-e	4	08LP	TU-04-30	Biface flake	Ojcc-e	15	08LP
TU-04-30	Flake fragment	Ojcc-e	52	08LP	TU-04-30	Primary flake	Ojcc-b	2	08LP
TU-04-30	Secondary flake	Ojcc-b	4	08LP	TU-04-30	Tertiary flake	Ojcc-b	7	08LP
TU-04-30	Biface flake	Ojcc-b	34	08LP	TU-04-30	Flake fragment	Ojcc-b	73	08LP
TU-04-30	Flake fragment	Ojcc-m	9	08LP	TU-04-31	Primary flake	Mbk	1	08LP
TU-04-31	Secondary flake	Mbk	1	08LP	TU-04-31	Biface flake	Mbk	4	08LP
TU-04-31	Flake fragment	Mbk	5	08LP	TU-04-31	Secondary flake	Mch	1	08LP
TU-04-31	Biface flake	Mch	3	08LP	TU-04-31	Flake fragment	Mch	4	08LP
TU-04-31	Biface flake	Ojcc-m	4	08LP	TU-04-31	Flake fragment	Ojcc-m	4	08LP
TU-04-31	Biface flake	Ojcc-b	4	08LP	TU-04-31	Flake fragment	Ojcc-b	11	08LP
TU-04-31	Biface flake	Ojcc-o	2	08LP	TU-04-31	Flake fragment	Ojcc-o	1	08LP
TU-04-31	Primary flake	Ojcc-e	3	08LP	TU-04-31	Secondary flake	Ojcc-e	8	08LP
TU-04-31	Tertiary flake	Ojcc-e	7	08LP	TU-04-31	Biface flake	Ojcc-e	11	08LP
TU-04-31	Flake fragment	Ojcc-e	41	08LP	TU-04-32	Secondary flake	Mbk	1	08LP
TU-04-32	Flake fragment	Mbk	8	08LP	TU-04-32	Biface flake	Mch	1	08LP
TU-04-32	Flake fragment	Mch	2	08LP	TU-04-32	Secondary flake	Ojcc-e	1	08LP
TU-04-32	Biface flake	Ojcc-e	12	08LP	TU-04-32	Flake fragment	Ojcc-e	11	08LP
TU-04-32	Biface flake	Ojcc-b	2	08LP	TU-04-32	Flake fragment	Ojcc-b	5	08LP
TU-04-32	Flake fragment	Ojcc-m	2	08LP	TU-04-32	Flake fragment	Ojcc-q	1	08LP
TU-04-33	Flake fragment	Ojcc-b	1	09EMP	TU-04-35	Secondary flake	Mbk	1	09EMP
TU-04-36	Secondary flake	Mbk	1	09EMP	TU-04-37	Biface flake	Ojcc-b	1	09EMP
TU-04-SW-26	Biface flake	Ojcc-m	1	07EEA	TU-04-SW-26	Flake fragment	Ojcc-m	2	07EEA
TU-04-SW-26	Flake fragment	Ojcc-o	1	07EEA	TU-04-SW-26	Flake fragment	Ojcc-e	2	07EEA
TU-04-SW-27	Secondary flake	Mbk	1	07EEA	TU-04-SW-27	Biface flake	Mbk	1	07EEA
TU-04-SW-27	Flake fragment	Mbk	1	07EEA	TU-04-SW-27	Biface flake	Ojcc-m	4	07EEA
TU-04-SW-27	Flake fragment	Ojcc-m	2	07EEA	TU-04-SW-27	Biface flake	Ojcc-b	2	07EEA
TU-04-SW-27	Flake fragment	Ojcc-b	3	07EEA	TU-04-SW-27	Biface flake	Ojcc-e	1	07EEA
TU-04-SW-27	Flake fragment	Ojcc-e	7	07EEA	TU-04-SW-27	Tertiary flake	Ojcc-c	1	07EEA
TU-04-SW-28	Flake fragment	Mbk	2	07EEA	TU-04-SW-28	Secondary flake	Ojcc-m	2	07EEA
TU-04-SW-28	Biface flake	Ojcc-m	4	07EEA	TU-04-SW-28	Flake fragment	Ojcc-m	6	07EEA
TU-04-SW-28	Biface flake	Ojcc-b	1	07EEA	TU-04-SW-28	Flake fragment	Ojcc-b	4	07EEA
TU-04-SW-28	Biface flake	Ojcc-e	2	07EEA	TU-04-SW-28	Flake fragment	Ojcc-e	6	07EEA
TU-04-SW-29	Biface flake	Mbk	2		TU-04-SW-29	Flake fragment	Mbk	2	
TU-04-SW-29	Biface flake	Mch	2		TU-04-SW-29	Primary flake	Ojcc-m	3	
TU-04-SW-29	Flake fragment	Ojcc-m	3		TU-04-SW-29	Biface flake	Ojcc-b	3	
TU-04-SW-29	Flake fragment	Ojcc-b	8		TU-04-SW-29	Biface flake	Ojcc-e	5	
TU-04-SW-29	Flake fragment	Ojcc-e	7		TU-04-SW-30	Biface flake	Mbk	4	08LP
TU-04-SW-30	Flake fragment	Mbk	10	08LP	TU-04-SW-30	Biface flake	Mch	2	08LP
TU-04-SW-30	Flake fragment	Mch	5	08LP	TU-04-SW-30	Biface flake	Ojcc-m	7	08LP
TU-04-SW-30	Flake fragment	Ojcc-m	29	08LP	TU-04-SW-30	Secondary flake	Ojcc-b	1	08LP
TU-04-SW-30	Tertiary flake	Ojcc-b	3	08LP	TU-04-SW-30	Biface flake	Ojcc-b	18	08LP
TU-04-SW-30	Flake fragment	Ojcc-b	40	08LP	TU-04-SW-30	Primary flake	Ojcc-e	4	08LP
TU-04-SW-30	Secondary flake	Ojcc-e	2	08LP	TU-04-SW-30	Tertiary flake	Ojcc-e	3	08LP
TU-04-SW-30	Biface flake	Ojcc-e	26	08LP	TU-04-SW-30	Flake fragment	Ojcc-e	85	08LP
TU-04-SW-30	Biface flake	Ojcc-o	2	08LP	TU-04-SW-30	Flake fragment	Ojcc-o	3	08LP
TU-04-SW-31	Biface flake	Mbk	1	08LP	TU-04-SW-31	Flake fragment	Mbk	7	08LP
TU-04-SW-31	Tertiary flake	Mch	1	08LP	TU-04-SW-31	Biface flake	Mch	3	08LP
TU-04-SW-31	Flake fragment	Mch	8	08LP	TU-04-SW-31	Secondary flake	Ojcc-m	2	08LP
TU-04-SW-31	Tertiary flake	Ojcc-m	2	08LP	TU-04-SW-31	Biface flake	Ojcc-m	4	08LP
TU-04-SW-31	Flake fragment	Ojcc-m	5	08LP	TU-04-SW-31	Biface flake	Ojcc-b	2	08LP
TU-04-SW-31	Flake fragment	Ojcc-b	7	08LP	TU-04-SW-31	Biface flake	Ojcc-o	1	08LP
TU-04-SW-31	Primary flake	Ojcc-e	5	08LP	TU-04-SW-31	Secondary flake	Ojcc-e	6	08LP
TU-04-SW-31	Tertiary flake	Ojcc-e	6	08LP	TU-04-SW-31	Biface flake	Ojcc-e	27	08LP
TU-04-SW-31	Flake fragment	Ojcc-e	60	08LP	TU-04-SW-32	Biface flake	Ojcc-m	1	08LP
TU-04-SW-32	Flake fragment	Ojcc-b	1	08LP	TU-04-SW-32	Secondary flake	Ojcc-e	1	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-04-SW-32	Biface flake	Ojcc-e	2	08LP	TU-04-SW-32	Flake fragment	Ojcc-e	1	08LP
TU-05-24	Primary flake	Mbk	4	03MLA	TU-05-24	Secondary flake	Mbk	10	03MLA
TU-05-24	Tertiary flake	Mbk	7	03MLA	TU-05-24	Biface flake	Mbk	15	03MLA
TU-05-24	Flake fragment	Mbk	26	03MLA	TU-05-24	Secondary flake	Ojcc-m	1	03MLA
TU-05-24	Tertiary flake	Ojcc-m	1	03MLA	TU-05-24	Biface flake	Ojcc-m	1	03MLA
TU-05-24	Flake fragment	Ojcc-m	2	03MLA	TU-05-24	Tested cobble	Ojcc-o	1	03MLA
TU-05-24	Secondary flake	Ojcc-o	1	03MLA	TU-05-24	Tertiary flake	Ojcc-o	1	03MLA
TU-05-24	Biface flake	Ojcc-e	1	03MLA	TU-05-25	Working core	Mbk	1	03MLA
TU-05-25	Primary flake	Mbk	2	03MLA	TU-05-25	Secondary flake	Mbk	12	03MLA
TU-05-25	Tertiary flake	Mbk	6	03MLA	TU-05-25	Biface flake	Mbk	14	03MLA
TU-05-25	Flake fragment	Mbk	22	03MLA	TU-05-25	Biface flake	Ojcc-e	2	03MLA
TU-05-25	Flake fragment	Ojcc-b	1	03MLA	TU-05-26	Secondary flake	Mbk	1	03MLA
TU-05-26	Flake fragment	Mbk	3	03MLA	TU-05-SW-24	Primary flake	Mbk	6	03MLA
TU-05-SW-24	Secondary flake	Mbk	24	03MLA	TU-05-SW-24	Tertiary flake	Mbk	7	03MLA
TU-05-SW-24	Biface flake	Mbk	28	03MLA	TU-05-SW-24	Flake fragment	Mbk	44	03MLA
TU-05-SW-24	Secondary flake	Ojcc-m	1	03MLA	TU-05-SW-24	Tertiary flake	Ojcc-m	1	03MLA
TU-05-SW-25	Primary flake	Mbk	3	03MLA	TU-05-SW-25	Secondary flake	Mbk	4	03MLA
TU-05-SW-25	Tertiary flake	Mbk	5	03MLA	TU-05-SW-25	Biface flake	Mbk	27	03MLA
TU-05-SW-25	Flake fragment	Mbk	43	03MLA	TU-05-SW-25	Secondary flake	Ojcc-m	1	03MLA
TU-05-SW-26	Primary flake	Mbk	1	03MLA	TU-05-SW-26	Secondary flake	Mbk	1	03MLA
TU-05-SW-26	Biface flake	Mbk	2	03MLA	TU-05-SW-26	Flake fragment	Mbk	2	03MLA
TU-06-1	Tested cobble	Mbk	1	022WLA	TU-06-1	Secondary flake	Mbk	7	022WLA
TU-06-1	Tertiary flake	Mbk	4	022WLA	TU-06-1	Biface flake	Mbk	5	022WLA
TU-06-1	Flake fragment	Mbk	10	022WLA	TU-06-1	Secondary flake	Mch	1	022WLA
TU-06-2	Primary flake	Mbk	1	022WLA	TU-06-2	Biface flake	Mbk	1	022WLA
TU-06-2	Flake fragment	Mbk	3	022WLA	TU-06-2	Secondary flake	Mch	1	022WLA
TU-06-37	Biface flake	Ojcc-m	2	022WLA	TU-06-37	Flake fragment	Ojcc-b	1	022WLA
TU-06-37	Flake fragment	Ojcc-q	1	022WLA	TU-08-26	Flake fragment	Mpk	1	07EEA
TU-08-26	Primary flake	Mbk	1	07EEA	TU-08-26	Biface flake	Mbk	1	07EEA
TU-08-26	Biface flake	Mch	2	07EEA	TU-08-26	Flake fragment	Mch	4	07EEA
TU-08-26	Secondary flake	Ojcc-e	1	07EEA	TU-08-26	Flake fragment	Ojcc-e	8	07EEA
TU-08-26	Biface flake	Ojcc-b	2	07EEA	TU-08-26	Flake fragment	Ojcc-b	3	07EEA
TU-08-26	Secondary flake	Ojcc-m	1	07EEA	TU-08-27	Tertiary flake	Mbk	1	07EEA
TU-08-27	Flake fragment	Mbk	2	07EEA	TU-08-27	Biface flake	Mch	2	07EEA
TU-08-27	Flake fragment	Mch	1	07EEA	TU-08-27	Primary flake	Ojcc-e	3	07EEA
TU-08-27	Secondary flake	Ojcc-e	2	07EEA	TU-08-27	Tertiary flake	Ojcc-e	1	07EEA
TU-08-27	Biface flake	Ojcc-e	5	07EEA	TU-08-27	Flake fragment	Ojcc-e	7	07EEA
TU-08-27	Primary flake	Ojcc-b	1	07EEA	TU-08-27	Biface flake	Ojcc-b	3	07EEA
TU-08-27	Flake fragment	Ojcc-b	4	07EEA	TU-08-27	Secondary flake	Ojcc-q	1	07EEA
TU-08-27	Flake fragment	Ojcc-q	1	07EEA	TU-08-28	Biface flake	Mbk	1	07EEA
TU-08-28	Flake fragment	Mbk	1	07EEA	TU-08-28	Secondary flake	Mch	1	07EEA
TU-08-28	Biface flake	Mch	1	07EEA	TU-08-28	Flake fragment	Mch	6	07EEA
TU-08-28	Primary flake	Ojcc-e	1	07EEA	TU-08-28	Secondary flake	Ojcc-e	2	07EEA
TU-08-28	Tertiary flake	Ojcc-e	1	07EEA	TU-08-28	Biface flake	Ojcc-e	4	07EEA
TU-08-28	Flake fragment	Ojcc-e	17	07EEA	TU-08-28	Secondary flake	Ojcc-b	2	07EEA
TU-08-28	Flake fragment	Ojcc-b	2	07EEA	TU-08-28	Biface flake	Ojcc-q	1	07EEA
TU-08-28	Flake fragment	Ojcc-q	4	07EEA	TU-08-28	Flake fragment	Ojcc-m	1	07EEA
TU-08-28	Flake fragment	Ojcc-o	1	07EEA	TU-08-29	Flake fragment	Mbk	1	
TU-08-29	Primary flake	Mch	1		TU-08-29	Secondary flake	Mch	2	
TU-08-29	Flake fragment	Mch	2		TU-08-29	Primary flake	Ojcc-e	3	
TU-08-29	Secondary flake	Ojcc-e	2		TU-08-29	Tertiary flake	Ojcc-e	2	
TU-08-29	Biface flake	Ojcc-e	11		TU-08-29	Flake fragment	Ojcc-e	13	
TU-08-29	Primary flake	Ojcc-b	1		TU-08-29	Secondary flake	Ojcc-b	1	
TU-08-29	Biface flake	Ojcc-b	7		TU-08-29	Flake fragment	Ojcc-b	11	
TU-08-29	Flake fragment	Ojcc-q	1		TU-08-30	Tertiary flake	Mbk	1	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-08-30	Biface flake	Mbk	5	08LP	TU-08-30	Flake fragment	Mbk	2	08LP
TU-08-30	Biface flake	Mch	2	08LP	TU-08-30	Flake fragment	Mch	3	08LP
TU-08-30	Tested cobble	Ojcc-e	1	08LP	TU-08-30	Primary flake	Ojcc-e	2	08LP
TU-08-30	Secondary flake	Ojcc-e	6	08LP	TU-08-30	Biface flake	Ojcc-e	11	08LP
TU-08-30	Flake fragment	Ojcc-e	40	08LP	TU-08-30	Primary flake	Ojcc-b	1	08LP
TU-08-30	Secondary flake	Ojcc-b	1	08LP	TU-08-30	Biface flake	Ojcc-b	6	08LP
TU-08-30	Flake fragment	Ojcc-b	12	08LP	TU-08-30	Tertiary flake	Ojcc-q	2	08LP
TU-08-30	Biface flake	Ojcc-q	3	08LP	TU-08-30	Flake fragment	Ojcc-q	2	08LP
TU-08-30	Biface flake	Ojcc-m	2	08LP	TU-08-30	Flake fragment	Ojcc-m	1	08LP
TU-08-30	Flake fragment	Ojcc-o	1	08LP	TU-08-31	Tertiary flake	Mbk	1	08LP
TU-08-31	Flake fragment	Mbk	6	08LP	TU-08-31	Secondary flake	Mch	1	08LP
TU-08-31	Biface flake	Mch	1	08LP	TU-08-31	Flake fragment	Mch	2	08LP
TU-08-31	Primary flake	Ojcc-e	3	08LP	TU-08-31	Secondary flake	Ojcc-e	4	08LP
TU-08-31	Tertiary flake	Ojcc-e	5	08LP	TU-08-31	Biface flake	Ojcc-e	21	08LP
TU-08-31	Flake fragment	Ojcc-e	54	08LP	TU-08-31	Secondary flake	Ojcc-b	1	08LP
TU-08-31	Biface flake	Ojcc-b	7	08LP	TU-08-31	Flake fragment	Ojcc-b	14	08LP
TU-08-31	Biface flake	Ojcc-q	5	08LP	TU-08-31	Flake fragment	Ojcc-q	6	08LP
TU-08-31	Flake fragment	Ojcc-m	1	08LP	TU-08-31	Flake fragment	Ex	1	08LP
TU-08-32	Tertiary flake	Mbk	1	08LP	TU-08-32	Biface flake	Mbk	2	08LP
TU-08-32	Flake fragment	Mbk	1	08LP	TU-08-32	Primary flake	Mch	1	08LP
TU-08-32	Biface flake	Mch	1	08LP	TU-08-32	Primary flake	Ojcc-e	1	08LP
TU-08-32	Secondary flake	Ojcc-e	1	08LP	TU-08-32	Tertiary flake	Ojcc-e	1	08LP
TU-08-32	Biface flake	Ojcc-e	8	08LP	TU-08-32	Flake fragment	Ojcc-e	10	08LP
TU-08-32	Biface flake	Ojcc-b	3	08LP	TU-08-32	Flake fragment	Ojcc-b	2	08LP
TU-08-32	Biface flake	Ojcc-q	1	08LP	TU-08-32	Flake fragment	Ojcc-q	1	08LP
TU-08-32	Flake fragment	Ojcc-m	3	08LP	TU-08-33	Flake fragment	Mbk	2	09EMP
TU-08-33	Biface flake	Mch	1	09EMP	TU-08-33	Secondary flake	Ojcc-e	1	09EMP
TU-08-33	Biface flake	Ojcc-e	4	09EMP	TU-08-33	Flake fragment	Ojcc-e	5	09EMP
TU-08-33	Flake fragment	Ojcc-b	2	09EMP	TU-08-33	Biface flake	Ojcc-q	1	09EMP
TU-08-SW-30	Primary flake	Mbk	1	08LP	TU-08-SW-30	Biface flake	Mbk	2	08LP
TU-08-SW-30	Flake fragment	Mbk	4	08LP	TU-08-SW-30	Flake fragment	Mch	2	08LP
TU-08-SW-30	Primary flake	Ojcc-e	1	08LP	TU-08-SW-30	Secondary flake	Ojcc-e	2	08LP
TU-08-SW-30	Tertiary flake	Ojcc-e	1	08LP	TU-08-SW-30	Biface flake	Ojcc-e	15	08LP
TU-08-SW-30	Flake fragment	Ojcc-e	23	08LP	TU-08-SW-30	Secondary flake	Ojcc-b	1	08LP
TU-08-SW-30	Tertiary flake	Ojcc-b	2	08LP	TU-08-SW-30	Biface flake	Ojcc-b	15	08LP
TU-08-SW-30	Flake fragment	Ojcc-b	30	08LP	TU-08-SW-30	Secondary flake	Ojcc-q	1	08LP
TU-08-SW-30	Biface flake	Ojcc-q	1	08LP	TU-08-SW-30	Flake fragment	Ojcc-q	1	08LP
TU-08-SW-30	Flake fragment	Ojcc-o	1	08LP	TU-08-SW-31	Flake fragment	Mbk	2	08LP
TU-08-SW-31	Flake fragment	Mch	3	08LP	TU-08-SW-31	Secondary flake	Ojcc-e	1	08LP
TU-08-SW-31	Tertiary flake	Ojcc-e	1	08LP	TU-08-SW-31	Biface flake	Ojcc-e	8	08LP
TU-08-SW-31	Flake fragment	Ojcc-e	29	08LP	TU-08-SW-31	Primary flake	Ojcc-b	1	08LP
TU-08-SW-31	Secondary flake	Ojcc-b	1	08LP	TU-08-SW-31	Biface flake	Ojcc-b	8	08LP
TU-08-SW-31	Flake fragment	Ojcc-b	15	08LP	TU-08-SW-31	Tertiary flake	Ojcc-q	2	08LP
TU-08-SW-31	Biface flake	Ojcc-q	4	08LP	TU-08-SW-31	Flake fragment	Ojcc-q	6	08LP
TU-08-SW-31	Flake fragment	Ojcc-m	2	08LP	TU-09-24	Tertiary flake	Mbk	2	03MLA
TU-09-24	Biface flake	Mbk	2	03MLA	TU-09-24	Flake fragment	Mbk	15	03MLA
TU-09-24	Flake fragment	Ojcc-e	1	03MLA	TU-09-25	Secondary flake	Mbk	1	03MLA
TU-09-25	Biface flake	Mbk	7	03MLA	TU-09-25	Flake fragment	Mbk	6	03MLA
TU-09-26	Secondary flake	Mbk	1	03MLA	TU-09-26	Tertiary flake	Mbk	1	03MLA
TU-09-26	Flake fragment	Mbk	2	03MLA	TU-10-25	Secondary flake	Ojcc-e	1	07EEA
TU-10-25	Flake fragment	Ojcc-e	1	07EEA	TU-10-26	Flake fragment	Ojcc-e	1	07EEA
TU-10-27	Flake fragment	Ojcc-e	1	07EEA	TU-10-28	Biface flake	Mbk	1	07EEA
TU-10-28	Flake fragment	Mbk	1	07EEA	TU-10-28	Secondary flake	Ojcc-e	1	07EEA
TU-10-28	Flake fragment	Ojcc-e	2	07EEA	TU-10-28	Biface flake	Ojcc-b	1	07EEA
TU-10-28	Flake fragment	Ojcc-b	2	07EEA	TU-10-28	Biface flake	Ojcc-o	1	07EEA

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-10-29	Flake fragment	Mbk	1		TU-10-29	Secondary flake	Ojcc-e	1	
TU-10-29	Biface flake	Ojcc-e	1		TU-10-29	Flake fragment	Ojcc-e	4	
TU-10-29	Biface flake	Ojcc-b	1		TU-10-29	Flake fragment	Ojcc-b	1	
TU-10-30	Tertiary flake	Mbk	1	08LP	TU-10-30	Biface flake	Mbk	2	08LP
TU-10-30	Flake fragment	Mbk	2	08LP	TU-10-30	Biface flake	Mrs-l	1	08LP
TU-10-30	Biface flake	Mch	1	08LP	TU-10-30	Secondary flake	Ojcc-e	1	08LP
TU-10-30	Tertiary flake	Ojcc-e	1	08LP	TU-10-30	Biface flake	Ojcc-e	7	08LP
TU-10-30	Flake fragment	Ojcc-e	10	08LP	TU-10-30	Biface flake	Ojcc-b	2	08LP
TU-10-30	Flake fragment	Ojcc-m	2	08LP	TU-10-31	Flake fragment	Mch	2	08LP
TU-10-31	Secondary flake	Ojcc-e	1	08LP	TU-10-31	Biface flake	Ojcc-e	4	08LP
TU-10-31	Flake fragment	Ojcc-e	9	08LP	TU-10-31	Secondary flake	Ojcc-b	1	08LP
TU-10-31	Biface flake	Ojcc-b	3	08LP	TU-10-31	Flake fragment	Ojcc-b	6	08LP
TU-10-31	Biface flake	Ojcc-q	1	08LP	TU-10-31	Flake fragment	Ojcc-m	2	08LP
TU-10-32	Biface flake	Mrs-l	1	08LP	TU-10-32	Primary flake	Ojcc-e	1	08LP
TU-10-32	Secondary flake	Ojcc-e	6	08LP	TU-10-32	Biface flake	Ojcc-e	19	08LP
TU-10-32	Flake fragment	Ojcc-e	23	08LP	TU-10-32	Flake fragment	Ojcc-b	5	08LP
TU-10-32	Tested cobble	Ojcc-m	1	08LP	TU-10-32	Working core	Ojcc-m	1	08LP
TU-10-32	Tertiary flake	Ojcc-m	4	08LP	TU-10-32	Flake fragment	Ojcc-m	8	08LP
TU-10-32	Tested cobble	Mbk	1	08LP	TU-10-33	Flake fragment	Mbk	1	
TU-10-33	Flake fragment	Ojcc-m	1		TU-10-34	Flake fragment	Ojcc-e	1	
TU-11-26	Biface flake	Mbk	1	07EEA	TU-11-26	Secondary flake	Ojcc-e	1	07EEA
TU-11-26	Flake fragment	Ojcc-e	1	07EEA	TU-11-26	Biface flake	Ojcc-b	1	07EEA
TU-11-26	Flake fragment	Ojcc-b	1	07EEA	TU-11-26	Biface flake	Ojcc-o	1	07EEA
TU-11-27	Flake fragment	Mbk	1	07EEA	TU-11-27	Biface flake	Ojcc-e	2	07EEA
TU-11-27	Flake fragment	Ojcc-e	2	07EEA	TU-11-27	Flake fragment	Ojcc-b	2	07EEA
TU-11-27	Primary flake	Ojcc-m	1	07EEA	TU-11-28	Flake fragment	Mpk	1	07EEA
TU-11-28	Tertiary flake	Mbk	1	07EEA	TU-11-28	Biface flake	Ojcc-e	1	07EEA
TU-11-28	Flake fragment	Ojcc-e	1	07EEA	TU-11-28	Secondary flake	Ojcc-b	1	07EEA
TU-11-28	Tertiary flake	Ojcc-b	1	07EEA	TU-11-28	Flake fragment	Ojcc-b	3	07EEA
TU-11-28	Biface flake	Ojcc-o	1	07EEA	TU-11-29	Biface flake	Mch	2	
TU-11-29	Secondary flake	Ojcc-e	1		TU-11-29	Biface flake	Ojcc-e	2	
TU-11-29	Flake fragment	Ojcc-e	5		TU-11-29	Secondary flake	Ojcc-b	1	
TU-11-29	Biface flake	Ojcc-b	1		TU-11-29	Flake fragment	Ojcc-b	5	
TU-11-30	Flake fragment	Mpk	2	08LP	TU-11-30	Biface flake	Mbk	1	08LP
TU-11-30	Flake fragment	Mbk	1	08LP	TU-11-30	Tertiary flake	Mch	1	08LP
TU-11-30	Flake fragment	Mch	1	08LP	TU-11-30	Secondary flake	Ojcc-e	4	08LP
TU-11-30	Tertiary flake	Ojcc-e	5	08LP	TU-11-30	Biface flake	Ojcc-e	16	08LP
TU-11-30	Flake fragment	Ojcc-e	36	08LP	TU-11-30	Primary flake	Ojcc-b	2	08LP
TU-11-30	Secondary flake	Ojcc-b	1	08LP	TU-11-30	Biface flake	Ojcc-b	4	08LP
TU-11-30	Flake fragment	Ojcc-b	6	08LP	TU-11-30	Biface flake	Ojcc-o	1	08LP
TU-11-30	Flake fragment	Ojcc-o	1	08LP	TU-11-30	Biface flake	Ojcc-q	1	08LP
TU-11-31	Tertiary flake	Mpk	2	08LP	TU-11-31	Flake fragment	Mpk	4	08LP
TU-11-31	Biface flake	Mbk	2	08LP	TU-11-31	Secondary flake	Ojcc-e	1	08LP
TU-11-31	Tertiary flake	Ojcc-e	2	08LP	TU-11-31	Biface flake	Ojcc-e	8	08LP
TU-11-31	Flake fragment	Ojcc-e	18	08LP	TU-11-31	Biface flake	Ojcc-b	1	08LP
TU-11-31	Flake fragment	Ojcc-b	1	08LP	TU-11-31	Biface flake	Ojcc-o	1	08LP
TU-11-31	Flake fragment	Ojcc-o	1	08LP	TU-11-31	Flake fragment	Ojcc-q	1	08LP
TU-11-32	Biface flake	Mpk	1	08LP	TU-11-32	Biface flake	Ojcc-e	6	08LP
TU-11-32	Flake fragment	Ojcc-e	2	08LP	TU-11-32	Secondary flake	Ojcc-b	1	08LP
TU-11-32	Biface flake	Ojcc-b	3	08LP	TU-11-32	Flake fragment	Ojcc-b	3	08LP
TU-11-32	Secondary flake	Ojcc-o	1	08LP	TU-12-26	Biface flake	Mbk	1	07EEA
TU-12-26	Primary flake	Ojcc-e	1	07EEA	TU-12-26	Flake fragment	Ojcc-e	3	07EEA
TU-12-27	Biface flake	Ojcc-e	1	07EEA	TU-12-27	Flake fragment	Ojcc-e	2	07EEA
TU-12-27	Flake fragment	Ojcc-b	5	07EEA	TU-12-27	Flake fragment	Ojcc-m	2	07EEA
TU-12-28	Flake fragment	Mch	1	07EEA	TU-12-28	Secondary flake	Ojcc-e	3	07EEA

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-12-28	Biface flake	Ojcc-e	3	07EEA	TU-12-28	Flake fragment	Ojcc-e	4	07EEA
TU-12-28	Tertiary flake	Ojcc-b	2	07EEA	TU-12-28	Biface flake	Ojcc-b	2	07EEA
TU-12-28	Flake fragment	Ojcc-b	2	07EEA	TU-12-28	Biface flake	Ojcc-m	1	07EEA
TU-12-28	Flake fragment	Ojcc-m	1	07EEA	TU-12-28	Primary flake	Ojcc-c	1	07EEA
TU-12-29	Biface flake	Mbk	2		TU-12-29	Flake fragment	Mbk	3	
TU-12-29	Biface flake	Mch	2		TU-12-29	Flake fragment	Mch	1	
TU-12-29	Primary flake	Ojcc-e	2		TU-12-29	Secondary flake	Ojcc-e	4	
TU-12-29	Tertiary flake	Ojcc-e	3		TU-12-29	Biface flake	Ojcc-e	9	
TU-12-29	Flake fragment	Ojcc-e	23		TU-12-29	Primary flake	Ojcc-b	1	
TU-12-29	Secondary flake	Ojcc-b	1		TU-12-29	Tertiary flake	Ojcc-b	3	
TU-12-29	Biface flake	Ojcc-b	6		TU-12-29	Flake fragment	Ojcc-b	29	
TU-12-29	Flake fragment	Ojcc-m	4		TU-12-29	Flake fragment	Ojcc-o	1	
TU-12-29	Biface flake	Ojcc-c	3		TU-12-29	Flake fragment	Ojcc-c	1	
TU-12-30	Biface flake	Mbk	1	08LP	TU-12-30	Flake fragment	Mbk	7	08LP
TU-12-30	Primary flake	Mch	1	08LP	TU-12-30	Secondary flake	Mch	2	08LP
TU-12-30	Biface flake	Mch	4	08LP	TU-12-30	Flake fragment	Mch	13	08LP
TU-12-30	Primary flake	Ojcc-e	5	08LP	TU-12-30	Secondary flake	Ojcc-e	15	08LP
TU-12-30	Tertiary flake	Ojcc-e	7	08LP	TU-12-30	Biface flake	Ojcc-e	38	08LP
TU-12-30	Flake fragment	Ojcc-e	79	08LP	TU-12-30	Primary flake	Ojcc-b	3	08LP
TU-12-30	Secondary flake	Ojcc-b	11	08LP	TU-12-30	Tertiary flake	Ojcc-b	8	08LP
TU-12-30	Biface flake	Ojcc-b	28	08LP	TU-12-30	Flake fragment	Ojcc-b	67	08LP
TU-12-30	Secondary flake	Ojcc-m	3	08LP	TU-12-30	Biface flake	Ojcc-m	4	08LP
TU-12-30	Flake fragment	Ojcc-m	12	08LP	TU-12-30	Flake fragment	Ojcc-c	5	08LP
TU-12-31	Secondary flake	Mbk	1	08LP	TU-12-31	Biface flake	Mbk	4	08LP
TU-12-31	Flake fragment	Mbk	7	08LP	TU-12-31	Biface flake	Mch	1	08LP
TU-12-31	Flake fragment	Mch	6	08LP	TU-12-31	Primary flake	Ojcc-e	10	08LP
TU-12-31	Secondary flake	Ojcc-e	11	08LP	TU-12-31	Tertiary flake	Ojcc-e	3	08LP
TU-12-31	Biface flake	Ojcc-e	42	08LP	TU-12-31	Flake fragment	Ojcc-e	63	08LP
TU-12-31	Tested cobble	Ojcc-b	1	08LP	TU-12-31	Secondary flake	Ojcc-b	2	08LP
TU-12-31	Tertiary flake	Ojcc-b	7	08LP	TU-12-31	Biface flake	Ojcc-b	21	08LP
TU-12-31	Flake fragment	Ojcc-b	46	08LP	TU-12-31	Primary flake	Ojcc-m	2	08LP
TU-12-31	Flake fragment	Ojcc-m	3	08LP	TU-12-31	Flake fragment	Ex	1	08LP
TU-12-32	Biface flake	Mbk	2	08LP	TU-12-32	Biface flake	Mch	1	08LP
TU-12-32	Flake fragment	Mch	1	08LP	TU-12-32	Secondary flake	Ojcc-e	1	08LP
TU-12-32	Tertiary flake	Ojcc-e	1	08LP	TU-12-32	Biface flake	Ojcc-e	6	08LP
TU-12-32	Flake fragment	Ojcc-e	12	08LP	TU-12-32	Flake fragment	Ojcc-b	4	08LP
TU-12-32	Primary flake	Ojcc-m	1	08LP	TU-12-32	Secondary flake	Ojcc-m	1	08LP
TU-12-33A	Flake fragment	Ojcc-b	1	09EMP	TU-12-33B	Biface flake	Ojcc-e	1	09EMP
TU-12-34A	Primary flake	Mbk	1	09EMP	TU-12-35A	Biface flake	Ojcc-e	1	09EMP
TU-12-35A	Flake fragment	Ojcc-e	2	09EMP	TU-12-35B	Flake fragment	Mbk	1	09EMP
TU-12-35B	Biface flake	Ojcc-e	1	09EMP	TU-13-30	Secondary flake	Mbk	1	08LP
TU-13-30	Flake fragment	Mbk	2	08LP	TU-13-30	Biface flake	Mch	2	08LP
TU-13-30	Flake fragment	Mch	6	08LP	TU-13-30	Primary flake	Ojcc-e	1	08LP
TU-13-30	Secondary flake	Ojcc-e	5	08LP	TU-13-30	Tertiary flake	Ojcc-e	2	08LP
TU-13-30	Biface flake	Ojcc-e	23	08LP	TU-13-30	Flake fragment	Ojcc-e	51	08LP
TU-13-30	Primary flake	Ojcc-b	1	08LP	TU-13-30	Tertiary flake	Ojcc-b	1	08LP
TU-13-30	Biface flake	Ojcc-b	10	08LP	TU-13-30	Flake fragment	Ojcc-b	16	08LP
TU-13-30	Primary flake	Ojcc-m	1	08LP	TU-13-30	Secondary flake	Ojcc-m	1	08LP
TU-13-30	Biface flake	Ojcc-m	2	08LP	TU-13-31	Secondary flake	Mch	1	08LP
TU-13-31	Flake fragment	Mch	3	08LP	TU-13-31	Tested cobble	Ojcc-e	1	08LP
TU-13-31	Primary flake	Ojcc-e	2	08LP	TU-13-31	Secondary flake	Ojcc-e	4	08LP
TU-13-31	Tertiary flake	Ojcc-e	3	08LP	TU-13-31	Biface flake	Ojcc-e	21	08LP
TU-13-31	Flake fragment	Ojcc-e	27	08LP	TU-13-31	Secondary flake	Ojcc-b	3	08LP
TU-13-31	Tertiary flake	Ojcc-b	2	08LP	TU-13-31	Biface flake	Ojcc-b	11	08LP
TU-13-31	Flake fragment	Ojcc-b	8	08LP	TU-13-31	Primary flake	Ojcc-m	1	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-13-31	Flake fragment	Ojcc-m	1	08LP	TU-13-32A	Tertiary flake	Ojcc-e	1	08LP
TU-13-32A	Biface flake	Ojcc-e	1	08LP	TU-13-32A	Flake fragment	Ojcc-e	1	08LP
TU-13-32B	Primary flake	Ojcc-e	1	08LP	TU-13-32B	Secondary flake	Ojcc-e	1	08LP
TU-13-32B	Biface flake	Ojcc-e	1	08LP	TU-13-32B	Flake fragment	Ojcc-e	5	08LP
TU-13-33A	Flake fragment	Ojcc-e	3	09EMP	TU-13-33A	Biface flake	Ojcc-b	1	09EMP
TU-13-34A	Biface flake	Ojcc-e	2	09EMP	TU-13-35	Biface flake	Ojcc-e	1	09EMP
TU-14-30	Biface flake	Mbk	1	08LP	TU-14-30	Flake fragment	Mbk	1	08LP
TU-14-30	Secondary flake	Mch	1	08LP	TU-14-30	Tertiary flake	Mch	1	08LP
TU-14-30	Biface flake	Mch	2	08LP	TU-14-30	Flake fragment	Mch	2	08LP
TU-14-30	Primary flake	Ojcc-e	1	08LP	TU-14-30	Secondary flake	Ojcc-e	1	08LP
TU-14-30	Tertiary flake	Ojcc-e	1	08LP	TU-14-30	Biface flake	Ojcc-e	8	08LP
TU-14-30	Flake fragment	Ojcc-e	18	08LP	TU-14-30	Secondary flake	Ojcc-b	2	08LP
TU-14-30	Tertiary flake	Ojcc-b	1	08LP	TU-14-30	Biface flake	Ojcc-b	25	08LP
TU-14-30	Flake fragment	Ojcc-b	43	08LP	TU-14-30	Biface flake	Ojcc-m	3	08LP
TU-14-30	Flake fragment	Ojcc-m	2	08LP	TU-14-30	Secondary flake	Ojcc-q	1	08LP
TU-14-30	Biface flake	Ojcc-o	1	08LP	TU-14-30	Flake fragment	Ojcc-o	3	08LP
TU-14-31	Tertiary flake	Mpk	1	08LP	TU-14-31	Biface flake	Mpk	1	08LP
TU-14-31	Flake fragment	Mpk	3	08LP	TU-14-31	Flake fragment	Mbk	2	08LP
TU-14-31	Secondary flake	Ojcc-e	3	08LP	TU-14-31	Biface flake	Ojcc-e	5	08LP
TU-14-31	Flake fragment	Ojcc-e	9	08LP	TU-14-31	Biface flake	Ojcc-b	2	08LP
TU-14-31	Biface flake	Ojcc-o	1	08LP	TU-14-31	Flake fragment	Ojcc-o	1	08LP
TU-14-31	Flake fragment	Ojcc-m	2	08LP	TU-15-30	Primary flake	Mbk	1	08LP
TU-15-30	Secondary flake	Mbk	3	08LP	TU-15-30	Tertiary flake	Mbk	2	08LP
TU-15-30	Biface flake	Mbk	8	08LP	TU-15-30	Flake fragment	Mbk	11	08LP
TU-15-30	Biface flake	Mch	1	08LP	TU-15-30	Flake fragment	Mch	1	08LP
TU-15-30	Primary flake	Ojcc-e	1	08LP	TU-15-30	Secondary flake	Ojcc-e	5	08LP
TU-15-30	Tertiary flake	Ojcc-e	3	08LP	TU-15-30	Biface flake	Ojcc-e	26	08LP
TU-15-30	Flake fragment	Ojcc-e	32	08LP	TU-15-30	Secondary flake	Ojcc-b	1	08LP
TU-15-30	Biface flake	Ojcc-b	3	08LP	TU-15-30	Flake fragment	Ojcc-m	2	08LP
TU-15-30	Biface flake	Ojcc-o	3	08LP	TU-15-30	Flake fragment	Ojcc-o	1	08LP
TU-15-30	Flake fragment	Ojcc-q	1	08LP	TU-15-31	Biface flake	Mbk	1	08LP
TU-15-31	Flake fragment	Mbk	1	08LP	TU-15-31	Tertiary flake	Ojcc-e	1	08LP
TU-15-31	Biface flake	Ojcc-e	3	08LP	TU-15-31	Secondary flake	Ojcc-b	1	08LP
TU-15-31	Flake fragment	Ojcc-b	1	08LP	TU-15-33A	Biface flake	Ojcc-e	1	09EMP
TU-15-33A	Flake fragment	Ojcc-e	1	09EMP	TU-15-33A	Biface flake	Ojcc-m	1	09EMP
TU-15-34	Biface flake	Ojcc-e	1	09EMP	TU-16-30	Biface flake	Mbk	1	08LP
TU-16-30	Flake fragment	Mbk	1	08LP	TU-16-30	Secondary flake	Mch	1	08LP
TU-16-30	Flake fragment	Mch	1	08LP	TU-16-30	Primary flake	Ojcc-e	2	08LP
TU-16-30	Secondary flake	Ojcc-e	2	08LP	TU-16-30	Biface flake	Ojcc-e	7	08LP
TU-16-30	Flake fragment	Ojcc-e	22	08LP	TU-16-30	Flake fragment	Ojcc-b	4	08LP
TU-16-30	Primary flake	Ojcc-c	1	08LP	TU-16-31	Flake fragment	Mpk	1	08LP
TU-16-31	Flake fragment	Mp-r	1	08LP	TU-16-31	Biface flake	Ojcc-e	6	08LP
TU-16-31	Flake fragment	Ojcc-e	3	08LP	TU-16-31	Tertiary flake	Ojcc-b	1	08LP
TU-16-31	Flake fragment	Ojcc-b	1	08LP	TU-16-32A	Primary flake	Ojcc-e	1	08LP
TU-16-34A	Biface flake	Ojcc-b	1	09EMP	TU-16-34A	Primary flake	Ojcc-q	1	09EMP
TU-16-35	Secondary flake	Mch	1	09EMP	TU-17-29	Biface flake	Mbk	1	
TU-17-29	Flake fragment	Mbk	1		TU-17-29	Flake fragment	Mch	2	
TU-17-29	Primary flake	Ojcc-e	2		TU-17-29	Biface flake	Ojcc-e	3	
TU-17-29	Flake fragment	Ojcc-e	4		TU-17-29	Biface flake	Ojcc-b	1	
TU-17-29	Biface flake	Ojcc-m	1		TU-17-29	Flake fragment	Ojcc-m	1	
TU-17-30	Biface flake	Mbk	1	08LP	TU-17-30	Flake fragment	Mbk	1	08LP
TU-17-30	Flake fragment	Mch	1	08LP	TU-17-30	Secondary flake	Ojcc-e	1	08LP
TU-17-30	Flake fragment	Ojcc-e	5	08LP	TU-17-30	Tertiary flake	Ojcc-b	1	08LP
TU-17-30	Flake fragment	Ojcc-b	5	08LP	TU-17-31	Secondary flake	Mbk	3	08LP
TU-17-31	Biface flake	Mbk	1	08LP	TU-17-31	Flake fragment	Mbk	1	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-17-31	Secondary flake	Mch	1	08LP	TU-17-31	Tertiary flake	Mch	1	08LP
TU-17-31	Flake fragment	Mch	1	08LP	TU-17-31	Primary flake	Ojcc-e	1	08LP
TU-17-31	Secondary flake	Ojcc-e	1	08LP	TU-17-31	Biface flake	Ojcc-e	5	08LP
TU-17-31	Flake fragment	Ojcc-e	10	08LP	TU-17-31	Tertiary flake	Ojcc-b	1	08LP
TU-17-31	Biface flake	Ojcc-b	1	08LP	TU-17-31	Flake fragment	Ojcc-b	7	08LP
TU-17-31	Biface flake	Ojcc-m	1	08LP	TU-17-32A	Primary flake	Ojcc-e	1	08LP
TU-17-32A	Secondary flake	Ojcc-e	1	08LP	TU-17-32A	Biface flake	Ojcc-b	1	08LP
TU-17-32A	Flake fragment	Ojcc-q	1	08LP	TU-17-32B	Flake fragment	Ojcc-e	2	08LP
TU-17-33A	Biface flake	Ojcc-e	2	09EMP	TU-17-33A	Flake fragment	Ojcc-e	1	09EMP
TU-17-33A	Secondary flake	Ojcc-b	1	09EMP	TU-17-33A	Biface flake	Ojcc-b	1	09EMP
TU-17-33B	Secondary flake	Ojcc-e	1	09EMP	TU-17-33B	Flake fragment	Ex	1	09EMP
TU-18-30	Biface flake	Mbk	2	08LP	TU-18-30	Flake fragment	Mbk	1	08LP
TU-18-30	Flake fragment	Mch	2	08LP	TU-18-30	Primary flake	Ojcc-e	1	08LP
TU-18-30	Tertiary flake	Ojcc-e	1	08LP	TU-18-30	Biface flake	Ojcc-e	6	08LP
TU-18-30	Flake fragment	Ojcc-e	17	08LP	TU-18-30	Primary flake	Ojcc-b	1	08LP
TU-18-30	Secondary flake	Ojcc-b	3	08LP	TU-18-30	Biface flake	Ojcc-b	5	08LP
TU-18-30	Flake fragment	Ojcc-b	3	08LP	TU-18-30	Biface flake	Ojcc-m	1	08LP
TU-18-30	Biface flake	Ex	1	08LP	TU-18-31	Biface flake	Ojcc-e	2	08LP
TU-18-31	Flake fragment	Ojcc-e	1	08LP	TU-18-31	Biface flake	Ojcc-b	1	08LP
TU-18-31	Flake fragment	Ojcc-b	1	08LP	TU-18-31	Biface flake	Ojcc-o	1	08LP
TU-18-32	Primary flake	Ojcc-e	1	08LP	TU-18-32	Flake fragment	Ojcc-e	1	08LP
TU-19-30	Biface flake	Mpk	1	08LP	TU-19-30	Biface flake	Mbk	4	08LP
TU-19-30	Flake fragment	Mbk	1	08LP	TU-19-30	Biface flake	Mch	2	08LP
TU-19-30	Flake fragment	Mch	2	08LP	TU-19-30	Primary flake	Ojcc-e	1	08LP
TU-19-30	Secondary flake	Ojcc-e	13	08LP	TU-19-30	Biface flake	Ojcc-e	18	08LP
TU-19-30	Flake fragment	Ojcc-e	41	08LP	TU-19-30	Primary flake	Ojcc-b	1	08LP
TU-19-30	Secondary flake	Ojcc-b	2	08LP	TU-19-30	Biface flake	Ojcc-b	12	08LP
TU-19-30	Flake fragment	Ojcc-b	21	08LP	TU-19-30	Primary flake	Ojcc-o	1	08LP
TU-19-30	Secondary flake	Ojcc-o	5	08LP	TU-19-30	Tertiary flake	Ojcc-o	5	08LP
TU-19-30	Biface flake	Ojcc-o	6	08LP	TU-19-30	Flake fragment	Ojcc-o	22	08LP
TU-19-30	Biface flake	Ojcc-m	1	08LP	TU-19-30	Flake fragment	Ojcc-m	2	08LP
TU-19-31	Biface flake	Mch	1	08LP	TU-19-31	Secondary flake	Ojcc-e	1	08LP
TU-19-31	Flake fragment	Ojcc-e	2	08LP	TU-19-31	Biface flake	Ojcc-b	1	08LP
TU-19-31	Biface flake	Ojcc-o	2	08LP	TU-19-31	Flake fragment	Ojcc-o	1	08LP
TU-19-31	Biface flake	Ojcc-m	1	08LP	TU-20-30	Secondary flake	Ojcc-e	2	08LP
TU-20-30	Biface flake	Ojcc-e	6	08LP	TU-20-30	Flake fragment	Ojcc-e	9	08LP
TU-20-30	Biface flake	Ojcc-b	6	08LP	TU-20-30	Flake fragment	Ojcc-b	9	08LP
TU-20-30	Secondary flake	Ojcc-o	1	08LP	TU-20-30	Biface flake	Ojcc-o	1	08LP
TU-20-30	Flake fragment	Ojcc-o	3	08LP	TU-20-31	Primary flake	Ojcc-e	1	08LP
TU-20-31	Secondary flake	Ojcc-e	1	08LP	TU-20-31	Flake fragment	Ojcc-b	1	08LP
TU-20-31	Flake fragment	Ojcc-m	1	08LP	TU-21-29	Biface flake	Mbk	2	
TU-21-29	Flake fragment	Mbk	4		TU-21-29	Secondary flake	Mch	1	
TU-21-29	Flake fragment	Mch	2		TU-21-29	Primary flake	Ojcc-e	1	
TU-21-29	Secondary flake	Ojcc-e	2		TU-21-29	Tertiary flake	Ojcc-e	1	
TU-21-29	Biface flake	Ojcc-e	4		TU-21-29	Flake fragment	Ojcc-e	12	
TU-21-29	Primary flake	Ojcc-b	1		TU-21-29	Secondary flake	Ojcc-b	7	
TU-21-29	Tertiary flake	Ojcc-b	6		TU-21-29	Biface flake	Ojcc-b	9	
TU-21-29	Flake fragment	Ojcc-b	20		TU-21-29	Biface flake	Ojcc-m	2	
TU-21-29	Flake fragment	Ojcc-m	6		TU-21-30	Secondary flake	Mbk	1	08LP
TU-21-30	Biface flake	Mbk	5	08LP	TU-21-30	Flake fragment	Mbk	8	08LP
TU-21-30	Secondary flake	Mch	2	08LP	TU-21-30	Biface flake	Mch	4	08LP
TU-21-30	Flake fragment	Mch	5	08LP	TU-21-30	Primary flake	Ojcc-e	3	08LP
TU-21-30	Secondary flake	Ojcc-e	7	08LP	TU-21-30	Tertiary flake	Ojcc-e	4	08LP
TU-21-30	Biface flake	Ojcc-e	49	08LP	TU-21-30	Flake fragment	Ojcc-e	67	08LP
TU-21-30	Secondary flake	Ojcc-b	10	08LP	TU-21-30	Tertiary flake	Ojcc-b	7	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-21-30	Biface flake	Ojcc-b	45	08LP	TU-21-30	Flake fragment	Ojcc-b	84	08LP
TU-21-30	Biface flake	Ojcc-m	3	08LP	TU-21-30	Flake fragment	Ojcc-m	7	08LP
TU-21-30	Flake fragment	Ojcc-o	2	08LP	TU-21-31	Secondary flake	Mbk	1	08LP
TU-21-31	Tertiary flake	Mbk	1	08LP	TU-21-31	Biface flake	Mbk	11	08LP
TU-21-31	Flake fragment	Mbk	15	08LP	TU-21-31	Primary flake	Mch	1	08LP
TU-21-31	Secondary flake	Mch	4	08LP	TU-21-31	Tertiary flake	Mch	2	08LP
TU-21-31	Biface flake	Mch	18	08LP	TU-21-31	Flake fragment	Mch	35	08LP
TU-21-31	Primary flake	Ojcc-e	6	08LP	TU-21-31	Secondary flake	Ojcc-e	16	08LP
TU-21-31	Tertiary flake	Ojcc-e	8	08LP	TU-21-31	Biface flake	Ojcc-e	45	08LP
TU-21-31	Flake fragment	Ojcc-e	96	08LP	TU-21-31	Primary flake	Ojcc-b	2	08LP
TU-21-31	Secondary flake	Ojcc-b	5	08LP	TU-21-31	Biface flake	Ojcc-b	25	08LP
TU-21-31	Flake fragment	Ojcc-b	31	08LP	TU-21-32	Biface flake	Mbk	2	08LP
TU-21-32	Flake fragment	Mbk	1	08LP	TU-21-32	Biface flake	Ojcc-e	6	08LP
TU-21-32	Flake fragment	Ojcc-e	9	08LP	TU-21-32	Flake fragment	Ojcc-b	2	08LP
TU-21-33A	Biface flake	Ojcc-b	1	09EMP	TU-21-34B	Flake fragment	Ojcc-e	1	09EMP
TU-21-34B	Flake fragment	Ojcc-b	1	09EMP	TU-22-29B	Secondary flake	Mch	1	
TU-22-29B	Secondary flake	Ojcc-b	1		TU-22-29B	Tertiary flake	Ojcc-b	3	
TU-22-29B	Flake fragment	Ojcc-b	2		TU-22-30	Secondary flake	Mbk	1	08LP
TU-22-30	Tertiary flake	Mbk	1	08LP	TU-22-30	Biface flake	Mbk	4	08LP
TU-22-30	Flake fragment	Mbk	4	08LP	TU-22-30	Primary flake	Mch	1	08LP
TU-22-30	Secondary flake	Mch	3	08LP	TU-22-30	Tertiary flake	Mch	2	08LP
TU-22-30	Biface flake	Mch	7	08LP	TU-22-30	Flake fragment	Mch	9	08LP
TU-22-30	Primary flake	Ojcc-e	3	08LP	TU-22-30	Secondary flake	Ojcc-e	9	08LP
TU-22-30	Tertiary flake	Ojcc-e	3	08LP	TU-22-30	Biface flake	Ojcc-e	22	08LP
TU-22-30	Flake fragment	Ojcc-e	45	08LP	TU-22-30	Secondary flake	Ojcc-b	8	08LP
TU-22-30	Tertiary flake	Ojcc-b	3	08LP	TU-22-30	Biface flake	Ojcc-b	40	08LP
TU-22-30	Flake fragment	Ojcc-b	80	08LP	TU-22-30	Tertiary flake	Ojcc-m	1	08LP
TU-22-30	Biface flake	Ojcc-c	1	08LP	TU-22-31	Primary flake	Mbk	1	08LP
TU-22-31	Secondary flake	Mbk	2	08LP	TU-22-31	Biface flake	Mbk	3	08LP
TU-22-31	Flake fragment	Mbk	2	08LP	TU-22-31	Primary flake	Mch	1	08LP
TU-22-31	Secondary flake	Mch	9	08LP	TU-22-31	Tertiary flake	Mch	3	08LP
TU-22-31	Biface flake	Mch	13	08LP	TU-22-31	Flake fragment	Mch	10	08LP
TU-22-31	Primary flake	Ojcc-e	3	08LP	TU-22-31	Secondary flake	Ojcc-e	9	08LP
TU-22-31	Tertiary flake	Ojcc-e	1	08LP	TU-22-31	Biface flake	Ojcc-e	22	08LP
TU-22-31	Flake fragment	Ojcc-e	42	08LP	TU-22-31	Primary flake	Ojcc-b	1	08LP
TU-22-31	Secondary flake	Ojcc-b	8	08LP	TU-22-31	Tertiary flake	Ojcc-b	11	08LP
TU-22-31	Biface flake	Ojcc-b	45	08LP	TU-22-31	Flake fragment	Ojcc-b	103	08LP
TU-22-31	Secondary flake	Ojcc-o	1	08LP	TU-22-31	Biface flake	Ojcc-m	3	08LP
TU-22-32	Biface flake	Mbk	2	08LP	TU-22-32	Flake fragment	Mbk	5	08LP
TU-22-32	Secondary flake	Mch	9	08LP	TU-22-32	Biface flake	Mch	21	08LP
TU-22-32	Flake fragment	Mch	26	08LP	TU-22-32	Primary flake	Ojcc-e	2	08LP
TU-22-32	Secondary flake	Ojcc-e	11	08LP	TU-22-32	Tertiary flake	Ojcc-e	3	08LP
TU-22-32	Biface flake	Ojcc-e	28	08LP	TU-22-32	Flake fragment	Ojcc-e	37	08LP
TU-22-32	Tested cobble	Ojcc-b	1	08LP	TU-22-32	Primary flake	Ojcc-b	3	08LP
TU-22-32	Secondary flake	Ojcc-b	6	08LP	TU-22-32	Biface flake	Ojcc-b	20	08LP
TU-22-32	Flake fragment	Ojcc-b	36	08LP	TU-22-32	Secondary flake	Ojcc-o	1	08LP
TU-22-32	Flake fragment	Ojcc-o	4	08LP	TU-22-33	Secondary flake	Mch	1	09EMP
TU-22-33	Biface flake	Mch	1	09EMP	TU-22-33	Flake fragment	Mch	2	09EMP
TU-22-33	Secondary flake	Ojcc-e	1	09EMP	TU-22-33	Biface flake	Ojcc-e	6	09EMP
TU-22-33	Flake fragment	Ojcc-e	17	09EMP	TU-22-33	Secondary flake	Ojcc-b	1	09EMP
TU-22-33	Tertiary flake	Ojcc-b	2	09EMP	TU-22-33	Biface flake	Ojcc-b	1	09EMP
TU-22-33	Flake fragment	Ojcc-b	3	09EMP	TU-22-33	Working core	Ojcc-o	1	09EMP
TU-22-33	Flake fragment	Ojcc-o	1	09EMP	TU-22-34	Flake fragment	Mch	1	09EMP
TU-22-34	Biface flake	Ojcc-e	2	09EMP	TU-22-34	Flake fragment	Ojcc-e	1	09EMP
TU-22-34	Biface flake	Ojcc-b	1	09EMP	TU-22-35B	Biface flake	Ojcc-e	1	09EMP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-22-35B	Flake fragment	Ojcc-e	1	09EMP	TU-23-29B	Biface flake	Mch	1	
TU-23-29B	Biface flake	Ojcc-e	1		TU-23-30	Biface flake	Mbk	1	
TU-23-30	Flake fragment	Mbk	2		TU-23-30	Secondary flake	Mch	1	
TU-23-30	Biface flake	Mch	4		TU-23-30	Flake fragment	Mch	2	
TU-23-30	Secondary flake	Ojcc-e	2		TU-23-30	Biface flake	Ojcc-e	2	
TU-23-30	Flake fragment	Ojcc-e	4		TU-23-30	Secondary flake	Ojcc-b	3	
TU-23-30	Biface flake	Ojcc-b	5		TU-23-30	Flake fragment	Ojcc-b	5	
TU-23-31	Flake fragment	Mbk	1		TU-23-31	Biface flake	Mch	1	
TU-23-31	Flake fragment	Mch	3		TU-23-31	Primary flake	Ojcc-e	1	
TU-23-31	Biface flake	Ojcc-e	7		TU-23-31	Flake fragment	Ojcc-e	8	
TU-23-31	Secondary flake	Ojcc-b	2		TU-23-31	Tertiary flake	Ojcc-b	2	
TU-23-31	Biface flake	Ojcc-b	7		TU-23-31	Flake fragment	Ojcc-b	9	
TU-23-31	Primary flake	Ojcc-m	1		TU-23-32A	Biface flake	Mch	3	
TU-23-32A	Flake fragment	Mch	1		TU-23-32A	Tertiary flake	Ojcc-e	1	
TU-23-32A	Biface flake	Ojcc-e	3		TU-23-32A	Flake fragment	Ojcc-e	5	
TU-23-32A	Biface flake	Ojcc-b	5		TU-23-32A	Flake fragment	Ojcc-b	6	
TU-23-32B	Flake fragment	Mbk	1		TU-23-32B	Tertiary flake	Mch	1	
TU-23-32B	Biface flake	Mch	2		TU-23-32B	Flake fragment	Mch	1	
TU-23-32B	Primary flake	Ojcc-e	1		TU-23-32B	Secondary flake	Ojcc-e	1	
TU-23-32B	Biface flake	Ojcc-e	5		TU-23-32B	Flake fragment	Ojcc-e	6	
TU-23-32B	Primary flake	Ojcc-b	4		TU-23-32B	Secondary flake	Ojcc-b	1	
TU-23-32B	Biface flake	Ojcc-b	1		TU-23-32B	Flake fragment	Ojcc-b	4	
TU-23-32B	Tertiary flake	Ojcc-m	1		TU-23-33A	Secondary flake	Mch	6	
TU-23-33A	Tertiary flake	Mch	4		TU-23-33A	Biface flake	Mch	20	
TU-23-33A	Flake fragment	Mch	24		TU-23-33A	Primary flake	Ojcc-e	2	
TU-23-33A	Secondary flake	Ojcc-e	3		TU-23-33A	Tertiary flake	Ojcc-e	3	
TU-23-33A	Biface flake	Ojcc-e	10		TU-23-33A	Flake fragment	Ojcc-e	14	
TU-23-33A	Primary flake	Ojcc-b	1		TU-23-33A	Tertiary flake	Ojcc-b	2	
TU-23-33A	Biface flake	Ojcc-b	2		TU-23-33A	Flake fragment	Ojcc-b	4	
TU-23-33B	Primary flake	Mch	1		TU-23-33B	Secondary flake	Mch	1	
TU-23-33B	Tertiary flake	Mch	1		TU-23-33B	Biface flake	Mch	6	
TU-23-33B	Flake fragment	Mch	9		TU-23-33B	Secondary flake	Ojcc-e	1	
TU-23-33B	Tertiary flake	Ojcc-e	1		TU-23-33B	Biface flake	Ojcc-e	8	
TU-23-33B	Flake fragment	Ojcc-e	12		TU-23-33B	Primary flake	Ojcc-b	1	
TU-23-33B	Secondary flake	Ojcc-b	2		TU-23-33B	Biface flake	Ojcc-b	3	
TU-23-33B	Flake fragment	Ojcc-b	8		TU-23-33B	Biface flake	Ojcc-o	2	
TU-23-34A	Secondary flake	Mch	1		TU-23-34A	Biface flake	Mch	1	
TU-23-34A	Flake fragment	Mch	2		TU-23-34A	Secondary flake	Ojcc-e	2	
TU-23-34A	Biface flake	Ojcc-e	3		TU-23-34A	Flake fragment	Ojcc-e	1	
TU-23-34A	Secondary flake	Ojcc-b	1		TU-23-34A	Biface flake	Ojcc-b	3	
TU-23-34B	Tertiary flake	Mbk	1		TU-23-34B	Biface flake	Mbk	1	
TU-23-34B	Secondary flake	Mch	1		TU-23-34B	Biface flake	Mch	3	
TU-23-34B	Flake fragment	Mch	2		TU-23-34B	Secondary flake	Ojcc-e	1	
TU-23-34B	Biface flake	Ojcc-e	1		TU-23-34B	Flake fragment	Ojcc-e	2	
TU-23-34B	Secondary flake	Ojcc-o	1		TU-23-35A	Secondary flake	Mbk	1	
TU-23-35A	Biface flake	Mbk	1		TU-23-35A	Flake fragment	Mbk	1	
TU-23-35A	Flake fragment	Mch	4		TU-23-35A	Secondary flake	Ojcc-e	1	
TU-23-35A	Tertiary flake	Ojcc-e	1		TU-23-35A	Biface flake	Ojcc-e	2	
TU-23-35A	Flake fragment	Ojcc-e	5		TU-23-35A	Secondary flake	Ojcc-b	1	
TU-23-35A	Biface flake	Ojcc-b	1		TU-23-35A	Flake fragment	Ojcc-b	1	
TU-23-35B	Biface flake	Mch	1		TU-23-35B	Flake fragment	Mch	1	
TU-23-35B	Biface flake	Ojcc-e	1		TU-23-35B	Flake fragment	Ojcc-e	1	
TU-23-35B	Tertiary flake	Ojcc-o	1		TU-23-36A	Biface flake	Ojcc-e	1	
TU-23-36B	Flake fragment	Ojcc-e	1		TU-23-36B	Flake fragment	Ojcc-b	1	
TU-24-30A	Biface flake	Mbk	1		TU-24-30A	Primary flake	Ojcc-e	1	

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-24-30A	Secondary flake	Ojcc-e	1		TU-24-30A	Secondary flake	Ojcc-b	1	
TU-24-30A	Biface flake	Ojcc-b	1		TU-24-30A	Flake fragment	Ojcc-b	3	
TU-24-30B	Primary flake	Ojcc-e	1		TU-24-30B	Biface flake	Ojcc-e	1	
TU-24-30B	Flake fragment	Ojcc-e	3		TU-24-30B	Biface flake	Ojcc-b	2	
TU-24-30B	Flake fragment	Ojcc-b	2		TU-24-31A	Secondary flake	Ojcc-e	1	
TU-24-31A	Biface flake	Ojcc-e	1		TU-24-31A	Flake fragment	Ojcc-e	5	
TU-24-31A	Biface flake	Ojcc-b	1		TU-24-31A	Flake fragment	Ojcc-b	5	
TU-24-31B	Secondary flake	Mbk	1		TU-24-31B	Flake fragment	Mbk	1	
TU-24-31B	Biface flake	Mch	1		TU-24-31B	Flake fragment	Mch	2	
TU-24-31B	Primary flake	Ojcc-e	1		TU-24-31B	Secondary flake	Ojcc-e	1	
TU-24-31B	Tertiary flake	Ojcc-e	1		TU-24-31B	Biface flake	Ojcc-e	2	
TU-24-31B	Flake fragment	Ojcc-e	7		TU-24-31B	Primary flake	Ojcc-b	1	
TU-24-31B	Secondary flake	Ojcc-b	1		TU-24-31B	Tertiary flake	Ojcc-b	1	
TU-24-31B	Biface flake	Ojcc-b	1		TU-24-31B	Flake fragment	Ojcc-b	5	
TU-24-31B	Flake fragment	Ojcc-m	1		TU-24-32A	Secondary flake	Mbk	1	
TU-24-32A	Flake fragment	Mbk	1		TU-24-32A	Flake fragment	Mch	1	
TU-24-32A	Biface flake	Ojcc-e	4		TU-24-32A	Flake fragment	Ojcc-e	5	
TU-24-32A	Flake fragment	Ojcc-b	3		TU-24-32B	Biface flake	Mch	2	
TU-24-32B	Flake fragment	Mch	1		TU-24-32B	Secondary flake	Ojcc-e	2	
TU-24-32B	Biface flake	Ojcc-e	2		TU-24-32B	Flake fragment	Ojcc-e	6	
TU-24-32B	Secondary flake	Ojcc-b	1		TU-24-32B	Flake fragment	Ojcc-b	3	
TU-24-33A	Biface flake	Mbk	1		TU-24-33A	Flake fragment	Mch	2	
TU-24-33A	Primary flake	Ojcc-e	1		TU-24-33A	Secondary flake	Ojcc-e	1	
TU-24-33A	Biface flake	Ojcc-e	6		TU-24-33A	Flake fragment	Ojcc-e	6	
TU-24-33A	Secondary flake	Ojcc-b	3		TU-24-33A	Flake fragment	Ojcc-b	5	
TU-24-33A	Flake fragment	Ojcc-o	1		TU-24-33B	Flake fragment	Mch	2	
TU-24-33B	Secondary flake	Ojcc-e	1		TU-24-33B	Biface flake	Ojcc-e	1	
TU-24-33B	Flake fragment	Ojcc-e	4		TU-24-33B	Secondary flake	Ojcc-b	1	
TU-24-33B	Tertiary flake	Ojcc-b	2		TU-24-33B	Biface flake	Ojcc-b	3	
TU-24-33B	Flake fragment	Ojcc-b	3		TU-24-33B	Biface flake	Ojcc-m	1	
TU-24-34A	Primary flake	Mbk	1		TU-24-34A	Flake fragment	Mbk	1	
TU-24-34A	Primary flake	Ojcc-e	1		TU-24-34A	Secondary flake	Ojcc-e	1	
TU-24-34A	Biface flake	Ojcc-e	2		TU-24-34A	Flake fragment	Ojcc-e	10	
TU-24-34A	Biface flake	Ojcc-b	3		TU-24-34A	Flake fragment	Ojcc-b	8	
TU-24-34B	Biface flake	Mbk	2		TU-24-34B	Flake fragment	Mbk	3	
TU-24-34B	Secondary flake	Mch	1		TU-24-34B	Biface flake	Mch	3	
TU-24-34B	Flake fragment	Mch	1		TU-24-34B	Primary flake	Ojcc-e	1	
TU-24-34B	Secondary flake	Ojcc-e	4		TU-24-34B	Tertiary flake	Ojcc-e	2	
TU-24-34B	Biface flake	Ojcc-e	5		TU-24-34B	Flake fragment	Ojcc-e	12	
TU-24-34B	Primary flake	Ojcc-b	1		TU-24-34B	Biface flake	Ojcc-b	3	
TU-24-34B	Flake fragment	Ojcc-b	6		TU-24-34B	Flake fragment	Ojcc-o	1	
TU-24-35A	Flake fragment	Mch	2		TU-24-35A	Primary flake	Ojcc-e	1	
TU-24-35A	Secondary flake	Ojcc-e	2		TU-24-35A	Tertiary flake	Ojcc-e	1	
TU-24-35A	Biface flake	Ojcc-e	6		TU-24-35A	Flake fragment	Ojcc-e	6	
TU-24-35A	Secondary flake	Ojcc-b	2		TU-24-35A	Biface flake	Ojcc-b	4	
TU-24-35A	Flake fragment	Ojcc-b	7		TU-24-35A	Biface flake	Ojcc-m	1	
TU-24-35A	Flake fragment	Ojcc-m	2		TU-24-35B	Flake fragment	Mbk	1	
TU-24-35B	Biface flake	Mch	1		TU-24-35B	Flake fragment	Ojcc-e	2	
TU-24-36A	Biface flake	Ojcc-e	2		TU-24-36A	Flake fragment	Ojcc-e	5	
TU-24-36A	Flake fragment	Ojcc-b	2		TU-24-36B	Primary flake	Mch	1	
TU-24-36B	Secondary flake	Mch	1		TU-24-36B	Biface flake	Ojcc-e	2	
TU-24-37A	Biface flake	Ojcc-b	2		TU-24-37B	Biface flake	Mch	1	
TU-24-37B	Flake fragment	Mch	1		TU-24-37B	Secondary flake	Ojcc-e	1	
TU-24-37B	Flake fragment	Ojcc-e	2		TU-24-37B	Flake fragment	Ojcc-b	1	
TU-24-38A	Biface flake	Ojcc-e	1		TU-24-38A	Flake fragment	Ojcc-b	1	

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-24-38B	Biface flake	Ojcc-b	1		TU-25-30	Secondary flake	Mbk	2	08LP
TU-25-30	Tertiary flake	Mbk	1	08LP	TU-25-30	Biface flake	Mbk	4	08LP
TU-25-30	Flake fragment	Mbk	5	08LP	TU-25-30	Biface flake	Mch	4	08LP
TU-25-30	Flake fragment	Mch	3	08LP	TU-25-30	Secondary flake	Ojcc-m	2	08LP
TU-25-30	Biface flake	Ojcc-m	1	08LP	TU-25-30	Flake fragment	Ojcc-m	11	08LP
TU-25-30	Primary flake	Ojcc-b	2	08LP	TU-25-30	Tertiary flake	Ojcc-b	4	08LP
TU-25-30	Biface flake	Ojcc-b	10	08LP	TU-25-30	Flake fragment	Ojcc-b	17	08LP
TU-25-30	Primary flake	Ojcc-e	3	08LP	TU-25-30	Secondary flake	Ojcc-e	6	08LP
TU-25-30	Tertiary flake	Ojcc-e	4	08LP	TU-25-30	Biface flake	Ojcc-e	24	08LP
TU-25-30	Flake fragment	Ojcc-e	31	08LP	TU-25-31	Flake fragment	Mpk	1	08LP
TU-25-31	Primary flake	Mbk	1	08LP	TU-25-31	Tertiary flake	Mbk	1	08LP
TU-25-31	Biface flake	Mbk	16	08LP	TU-25-31	Flake fragment	Mbk	12	08LP
TU-25-31	Primary flake	Mch	1	08LP	TU-25-31	Secondary flake	Mch	1	08LP
TU-25-31	Tertiary flake	Mch	1	08LP	TU-25-31	Biface flake	Mch	4	08LP
TU-25-31	Flake fragment	Mch	3	08LP	TU-25-31	Primary flake	Ojcc-e	9	08LP
TU-25-31	Secondary flake	Ojcc-e	23	08LP	TU-25-31	Tertiary flake	Ojcc-e	3	08LP
TU-25-31	Biface flake	Ojcc-e	41	08LP	TU-25-31	Flake fragment	Ojcc-e	111	08LP
TU-25-31	Primary flake	Ojcc-b	1	08LP	TU-25-31	Secondary flake	Ojcc-b	3	08LP
TU-25-31	Tertiary flake	Ojcc-b	5	08LP	TU-25-31	Biface flake	Ojcc-b	16	08LP
TU-25-31	Flake fragment	Ojcc-b	26	08LP	TU-25-31	Primary flake	Ojcc-m	1	08LP
TU-25-31	Biface flake	Ojcc-m	5	08LP	TU-25-31	Flake fragment	Ojcc-m	18	08LP
TU-25-31	Biface flake	Ojcc-o	1	08LP	TU-25-31	Flake fragment	Ojcc-o	2	08LP
TU-25-32	Secondary flake	Mbk	1	08LP	TU-25-32	Tertiary flake	Mbk	2	08LP
TU-25-32	Biface flake	Mbk	4	08LP	TU-25-32	Flake fragment	Mbk	10	08LP
TU-25-32	Working core	Mch	1	08LP	TU-25-32	Primary flake	Mch	1	08LP
TU-25-32	Secondary flake	Mch	3	08LP	TU-25-32	Tertiary flake	Mch	1	08LP
TU-25-32	Biface flake	Mch	1	08LP	TU-25-32	Flake fragment	Mch	7	08LP
TU-25-32	Primary flake	Ojcc-e	8	08LP	TU-25-32	Secondary flake	Ojcc-e	11	08LP
TU-25-32	Tertiary flake	Ojcc-e	7	08LP	TU-25-32	Biface flake	Ojcc-e	51	08LP
TU-25-32	Flake fragment	Ojcc-e	124	08LP	TU-25-32	Primary flake	Ojcc-b	2	08LP
TU-25-32	Tertiary flake	Ojcc-b	2	08LP	TU-25-32	Biface flake	Ojcc-b	7	08LP
TU-25-32	Flake fragment	Ojcc-b	16	08LP	TU-25-32	Secondary flake	Ojcc-m	2	08LP
TU-25-32	Biface flake	Ojcc-m	2	08LP	TU-25-32	Flake fragment	Ojcc-m	7	08LP
TU-25-32	Flake fragment	Ojcc-o	1	08LP	TU-25-33	Primary flake	Mbk	1	09EMP
TU-25-33	Biface flake	Mbk	1	09EMP	TU-25-33	Flake fragment	Mbk	4	09EMP
TU-25-33	Biface flake	Mch	3	09EMP	TU-25-33	Flake fragment	Mch	3	09EMP
TU-25-33	Primary flake	Ojcc-e	4	09EMP	TU-25-33	Secondary flake	Ojcc-e	6	09EMP
TU-25-33	Tertiary flake	Ojcc-e	3	09EMP	TU-25-33	Biface flake	Ojcc-e	32	09EMP
TU-25-33	Flake fragment	Ojcc-e	51	09EMP	TU-25-33	Biface flake	Ojcc-b	5	09EMP
TU-25-33	Flake fragment	Ojcc-b	13	09EMP	TU-25-33	Primary flake	Ojcc-m	1	09EMP
TU-25-33	Biface flake	Ojcc-m	1	09EMP	TU-25-33	Flake fragment	Ojcc-m	11	09EMP
TU-25-33	Biface flake	Ojcc-o	4	09EMP	TU-25-34	Secondary flake	Mbk	1	09EMP
TU-25-34	Biface flake	Mbk	3	09EMP	TU-25-34	Flake fragment	Mbk	1	09EMP
TU-25-34	Secondary flake	Mch	1	09EMP	TU-25-34	Flake fragment	Mch	1	09EMP
TU-25-34	Secondary flake	Ojcc-e	3	09EMP	TU-25-34	Tertiary flake	Ojcc-e	1	09EMP
TU-25-34	Biface flake	Ojcc-e	8	09EMP	TU-25-34	Flake fragment	Ojcc-e	31	09EMP
TU-25-34	Secondary flake	Ojcc-b	1	09EMP	TU-25-34	Tertiary flake	Ojcc-b	1	09EMP
TU-25-34	Biface flake	Ojcc-b	2	09EMP	TU-25-34	Flake fragment	Ojcc-b	8	09EMP
TU-25-34	Primary flake	Ojcc-m	2	09EMP	TU-25-34	Flake fragment	Ojcc-m	3	09EMP
TU-25-34	Biface flake	Ojcc-o	2	09EMP	TU-25-34	Flake fragment	Ojcc-o	1	09EMP
TU-25-35A	Secondary flake	Ojcc-e	2	09EMP	TU-25-35A	Biface flake	Ojcc-e	3	09EMP
TU-25-35A	Flake fragment	Ojcc-e	2	09EMP	TU-25-35A	Secondary flake	Ojcc-b	1	09EMP
TU-25-35A	Biface flake	Ojcc-m	1	09EMP	TU-25-35A	Flake fragment	Ojcc-m	1	09EMP
TU-25-35B	Primary flake	Ojcc-e	1	09EMP	TU-25-35B	Flake fragment	Ojcc-e	7	09EMP
TU-25-35B	Flake fragment	Ojcc-m	3	09EMP	TU-25-36A	Secondary flake	Ojcc-e	1	09EMP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-25-36A	Biface flake	Ojcc-e	2	09EMP	TU-25-36A	Flake fragment	Ojcc-b	1	09EMP
TU-25-36B	Biface flake	Mbk	1	09EMP	TU-25-36B	Biface flake	Ojcc-e	2	09EMP
TU-25-36B	Flake fragment	Ojcc-e	3	09EMP	TU-25-37A	Secondary flake	Mch	1	09EMP
TU-25-37A	Flake fragment	Ojcc-b	1	09EMP	TU-25-37A	Biface flake	Ojcc-m	1	09EMP
TU-25-37B	Tested cobble	Ojcc-e	1	09EMP	TU-25-38A	Flake fragment	Ojcc-m	1	10PP
TU-25-38B	Flake fragment	Mbk	1	10PP	TU-25-39	Flake fragment	Mbk	1	10PP
TU-25-39	Flake fragment	Ojcc-e	1	10PP	TU-25-39	Biface flake	Ojcc-b	1	10PP
TU-26-29B	Biface flake	Mbk	3		TU-26-29B	Primary flake	Mch	1	
TU-26-29B	Biface flake	Mch	1		TU-26-29B	Flake fragment	Mch	1	
TU-26-29B	Primary flake	Ojcc-e	1		TU-26-29B	Secondary flake	Ojcc-e	1	
TU-26-29B	Biface flake	Ojcc-e	4		TU-26-29B	Flake fragment	Ojcc-e	14	
TU-26-29B	Tertiary flake	Ojcc-b	2		TU-26-29B	Biface flake	Ojcc-b	3	
TU-26-29B	Flake fragment	Ojcc-b	8		TU-26-29B	Tertiary flake	Ojcc-m	1	
TU-26-29B	Flake fragment	Ojcc-m	1		TU-26-29B	Biface flake	Ojcc-c	1	
TU-26-30	Secondary flake	Mbk	2	08LP	TU-26-30	Tertiary flake	Mbk	1	08LP
TU-26-30	Biface flake	Mbk	7	08LP	TU-26-30	Flake fragment	Mbk	10	08LP
TU-26-30	Primary flake	Mch	2	08LP	TU-26-30	Secondary flake	Mch	3	08LP
TU-26-30	Tertiary flake	Mch	1	08LP	TU-26-30	Biface flake	Mch	6	08LP
TU-26-30	Flake fragment	Mch	18	08LP	TU-26-30	Primary flake	Ojcc-e	11	08LP
TU-26-30	Secondary flake	Ojcc-e	25	08LP	TU-26-30	Tertiary flake	Ojcc-e	3	08LP
TU-26-30	Biface flake	Ojcc-e	102	08LP	TU-26-30	Flake fragment	Ojcc-e	157	08LP
TU-26-30	Primary flake	Ojcc-b	2	08LP	TU-26-30	Secondary flake	Ojcc-b	9	08LP
TU-26-30	Tertiary flake	Ojcc-b	9	08LP	TU-26-30	Biface flake	Ojcc-b	59	08LP
TU-26-30	Flake fragment	Ojcc-b	98	08LP	TU-26-30	Secondary flake	Ojcc-c	1	08LP
TU-26-30	Biface flake	Ojcc-c	6	08LP	TU-26-30	Flake fragment	Ojcc-c	8	08LP
TU-26-30	Tertiary flake	Ojcc-m	1	08LP	TU-26-30	Biface flake	Ojcc-m	5	08LP
TU-26-30	Flake fragment	Ojcc-m	5	08LP	TU-26-30	Biface flake	Ojcc-o	1	08LP
TU-26-30	Flake fragment	Ojcc-o	4	08LP	TU-26-30	Biface flake	Ojcc-q	2	08LP
TU-26-30	Flake fragment	Mpk	1	08LP	TU-26-31	Secondary flake	Mbk	2	08LP
TU-26-31	Biface flake	Mbk	2	08LP	TU-26-31	Flake fragment	Mbk	8	08LP
TU-26-31	Primary flake	Mch	1	08LP	TU-26-31	Biface flake	Mch	4	08LP
TU-26-31	Flake fragment	Mch	8	08LP	TU-26-31	Primary flake	Ojcc-e	5	08LP
TU-26-31	Secondary flake	Ojcc-e	13	08LP	TU-26-31	Tertiary flake	Ojcc-e	7	08LP
TU-26-31	Biface flake	Ojcc-e	53	08LP	TU-26-31	Flake fragment	Ojcc-e	100	08LP
TU-26-31	Secondary flake	Ojcc-b	2	08LP	TU-26-31	Tertiary flake	Ojcc-b	1	08LP
TU-26-31	Biface flake	Ojcc-b	42	08LP	TU-26-31	Flake fragment	Ojcc-b	61	08LP
TU-26-31	Secondary flake	Ojcc-c	1	08LP	TU-26-31	Biface flake	Ojcc-c	1	08LP
TU-26-31	Flake fragment	Ojcc-c	3	08LP	TU-26-31	Tertiary flake	Ojcc-o	1	08LP
TU-26-31	Biface flake	Ojcc-m	3	08LP	TU-26-31	Flake fragment	Ojcc-m	2	08LP
TU-26-31	Biface flake	Ojcc-q	1	08LP	TU-26-31	Flake fragment	Ojcc-q	1	08LP
TU-26-32	Biface flake	Mbk	1	08LP	TU-26-32	Biface flake	Mch	3	08LP
TU-26-32	Flake fragment	Mch	2	08LP	TU-26-32	Secondary flake	Ojcc-e	9	08LP
TU-26-32	Tertiary flake	Ojcc-e	1	08LP	TU-26-32	Biface flake	Ojcc-e	24	08LP
TU-26-32	Flake fragment	Ojcc-e	51	08LP	TU-26-32	Secondary flake	Ojcc-b	3	08LP
TU-26-32	Biface flake	Ojcc-b	4	08LP	TU-26-32	Flake fragment	Ojcc-b	10	08LP
TU-26-32	Secondary flake	Ojcc-c	1	08LP	TU-26-32	Flake fragment	Ojcc-o	1	08LP
TU-26-33A	Flake fragment	Mbk	1	09EMP	TU-26-33A	Tertiary flake	Mch	1	09EMP
TU-26-33A	Biface flake	Mch	1	09EMP	TU-26-33A	Biface flake	Ojcc-e	3	09EMP
TU-26-33A	Flake fragment	Ojcc-e	4	09EMP	TU-26-33A	Biface flake	Ojcc-b	2	09EMP
TU-26-33A	Flake fragment	Ojcc-b	6	09EMP	TU-26-33B	Flake fragment	Mbk	2	09EMP
TU-26-33B	Biface flake	Mch	1	09EMP	TU-26-33B	Primary flake	Ojcc-e	1	09EMP
TU-26-33B	Biface flake	Ojcc-e	3	09EMP	TU-26-33B	Flake fragment	Ojcc-e	13	09EMP
TU-26-33B	Biface flake	Ojcc-b	2	09EMP	TU-26-33B	Flake fragment	Ojcc-b	5	09EMP
TU-26-33B	Biface flake	Ojcc-q	1	09EMP	TU-26-34A	Flake fragment	Mch	2	09EMP
TU-26-34A	Secondary flake	Ojcc-e	1	09EMP	TU-26-34A	Tertiary flake	Ojcc-e	1	09EMP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-26-34A	Biface flake	Ojcc-e	5	09EMP	TU-26-34A	Flake fragment	Ojcc-e	4	09EMP
TU-26-34A	Biface flake	Ojcc-b	3	09EMP	TU-26-34A	Flake fragment	Ojcc-m	1	09EMP
TU-26-34B	Biface flake	Mch	1	09EMP	TU-26-34B	Tertiary flake	Ojcc-e	1	09EMP
TU-26-34B	Biface flake	Ojcc-e	2	09EMP	TU-26-34B	Flake fragment	Ojcc-e	6	09EMP
TU-26-35A	Flake fragment	Mbk	2	09EMP	TU-26-35A	Flake fragment	Mch	1	09EMP
TU-26-35A	Biface flake	Ojcc-e	1	09EMP	TU-26-35A	Flake fragment	Ojcc-e	3	09EMP
TU-26-35A	Tertiary flake	Ojcc-b	1	09EMP	TU-26-35B	Secondary flake	Ojcc-e	1	09EMP
TU-27-30	Secondary flake	Mbk	3	08LP	TU-27-30	Tertiary flake	Mbk	2	08LP
TU-27-30	Biface flake	Mbk	2	08LP	TU-27-30	Flake fragment	Mbk	6	08LP
TU-27-30	Primary flake	Mch	1	08LP	TU-27-30	Secondary flake	Mch	2	08LP
TU-27-30	Tertiary flake	Mch	2	08LP	TU-27-30	Biface flake	Mch	12	08LP
TU-27-30	Flake fragment	Mch	16	08LP	TU-27-30	Primary flake	Ojcc-e	4	08LP
TU-27-30	Secondary flake	Ojcc-e	5	08LP	TU-27-30	Biface flake	Ojcc-e	31	08LP
TU-27-30	Flake fragment	Ojcc-e	40	08LP	TU-27-30	Secondary flake	Ojcc-b	3	08LP
TU-27-30	Biface flake	Ojcc-b	5	08LP	TU-27-30	Flake fragment	Ojcc-b	24	08LP
TU-27-30	Flake fragment	Ojcc-m	2	08LP	TU-27-30	Flake fragment	Ojcc-o	1	08LP
TU-27-31	Primary flake	Mbk	4	08LP	TU-27-31	Secondary flake	Mbk	2	08LP
TU-27-31	Tertiary flake	Mbk	1	08LP	TU-27-31	Biface flake	Mbk	2	08LP
TU-27-31	Flake fragment	Mbk	6	08LP	TU-27-31	Secondary flake	Mch	2	08LP
TU-27-31	Tertiary flake	Mch	4	08LP	TU-27-31	Biface flake	Mch	33	08LP
TU-27-31	Flake fragment	Mch	64	08LP	TU-27-31	Primary flake	Ojcc-e	9	08LP
TU-27-31	Secondary flake	Ojcc-e	22	08LP	TU-27-31	Tertiary flake	Ojcc-e	7	08LP
TU-27-31	Biface flake	Ojcc-e	79	08LP	TU-27-31	Flake fragment	Ojcc-e	122	08LP
TU-27-31	Primary flake	Ojcc-b	1	08LP	TU-27-31	Secondary flake	Ojcc-b	7	08LP
TU-27-31	Tertiary flake	Ojcc-b	1	08LP	TU-27-31	Biface flake	Ojcc-b	26	08LP
TU-27-31	Flake fragment	Ojcc-b	44	08LP	TU-27-31	Tertiary flake	Ojcc-m	1	08LP
TU-27-31	Biface flake	Ojcc-m	1	08LP	TU-27-31	Flake fragment	Ojcc-m	1	08LP
TU-27-31	Biface flake	Ojcc-o	2	08LP	TU-27-32	Biface flake	Mbk	1	08LP
TU-27-32	Secondary flake	Mch	1	08LP	TU-27-32	Biface flake	Mch	8	08LP
TU-27-32	Flake fragment	Mch	8	08LP	TU-27-32	Primary flake	Ojcc-e	2	08LP
TU-27-32	Secondary flake	Ojcc-e	4	08LP	TU-27-32	Tertiary flake	Ojcc-e	2	08LP
TU-27-32	Biface flake	Ojcc-e	15	08LP	TU-27-32	Flake fragment	Ojcc-e	22	08LP
TU-27-32	Primary flake	Ojcc-b	3	08LP	TU-27-32	Secondary flake	Ojcc-b	1	08LP
TU-27-32	Tertiary flake	Ojcc-b	6	08LP	TU-27-32	Biface flake	Ojcc-b	7	08LP
TU-27-32	Flake fragment	Ojcc-b	7	08LP	TU-27-32	Biface flake	Ojcc-m	2	08LP
TU-27-32	Flake fragment	Ojcc-o	1	08LP	TU-27-33A	Primary flake	Mbk	1	09EMP
TU-27-33A	Biface flake	Mch	2	09EMP	TU-27-33A	Flake fragment	Mch	3	09EMP
TU-27-33A	Biface flake	Ojcc-e	3	09EMP	TU-27-33A	Flake fragment	Ojcc-e	13	09EMP
TU-27-33A	Biface flake	Ojcc-b	1	09EMP	TU-27-33A	Flake fragment	Ojcc-b	3	09EMP
TU-27-33A	Flake fragment	Ojcc-o	1	09EMP	TU-27-33A	Biface flake	Ojcc-m	1	09EMP
TU-27-33B	Flake fragment	Mch	4	09EMP	TU-27-33B	Biface flake	Ojcc-e	5	09EMP
TU-27-33B	Flake fragment	Ojcc-e	3	09EMP	TU-27-33B	Biface flake	Ojcc-b	1	09EMP
TU-27-33B	Flake fragment	Ojcc-b	4	09EMP	TU-27-34A	Biface flake	Mch	2	09EMP
TU-27-34A	Flake fragment	Mch	5	09EMP	TU-27-34A	Tertiary flake	Ojcc-e	1	09EMP
TU-27-34A	Biface flake	Ojcc-e	2	09EMP	TU-27-34A	Flake fragment	Ojcc-e	6	09EMP
TU-27-34A	Biface flake	Ojcc-b	2	09EMP	TU-27-34A	Flake fragment	Ojcc-b	1	09EMP
TU-27-34A	Flake fragment	Ojcc-m	3	09EMP	TU-27-34B	Flake fragment	Mbk	1	09EMP
TU-27-34B	Biface flake	Ojcc-e	1	09EMP	TU-27-34B	Flake fragment	Ojcc-e	6	09EMP
TU-27-34B	Secondary flake	Ojcc-b	1	09EMP	TU-27-34B	Biface flake	Ojcc-b	3	09EMP
TU-27-34B	Biface flake	Ojcc-m	2	09EMP	TU-27-35A	Flake fragment	Mch	1	09EMP
TU-27-35A	Secondary flake	Ojcc-e	1	09EMP	TU-27-35A	Flake fragment	Ojcc-e	1	09EMP
TU-27-35A	Biface flake	Ojcc-b	1	09EMP	TU-27-35A	Flake fragment	Ojcc-b	1	09EMP
TU-27-35B	Flake fragment	Mbk	1	09EMP	TU-27-35B	Flake fragment	Mch	1	09EMP
TU-27-35B	Primary flake	Ojcc-e	1	09EMP	TU-27-35B	Biface flake	Ojcc-e	1	09EMP
TU-28-30	Flake fragment	Mbk	2		TU-28-30	Secondary flake	Ojcc-e	2	

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-28-30	Biface flake	Ojcc-e	8		TU-28-30	Flake fragment	Ojcc-e	13	
TU-28-30	Primary flake	Ojcc-b	2		TU-28-30	Secondary flake	Ojcc-b	2	
TU-28-30	Tertiary flake	Ojcc-b	1		TU-28-30	Biface flake	Ojcc-b	3	
TU-28-30	Flake fragment	Ojcc-b	8		TU-28-30	Flake fragment	Ojcc-m	1	
TU-28-30	Flake fragment	Ojcc-o	1		TU-28-30	Flake fragment	Ojcc-c	1	
TU-28-31	Primary flake	Mbk	1		TU-28-31	Biface flake	Mbk	2	
TU-28-31	Flake fragment	Mbk	4		TU-28-31	Biface flake	Mch	1	
TU-28-31	Flake fragment	Mch	5		TU-28-31	Primary flake	Ojcc-e	3	
TU-28-31	Secondary flake	Ojcc-e	2		TU-28-31	Tertiary flake	Ojcc-e	4	
TU-28-31	Biface flake	Ojcc-e	20		TU-28-31	Flake fragment	Ojcc-e	44	
TU-28-31	Primary flake	Ojcc-b	2		TU-28-31	Secondary flake	Ojcc-b	7	
TU-28-31	Tertiary flake	Ojcc-b	2		TU-28-31	Biface flake	Ojcc-b	15	
TU-28-31	Flake fragment	Ojcc-b	18		TU-28-31	Biface flake	Ojcc-m	1	
TU-28-31	Flake fragment	Ojcc-m	4		TU-28-32	Biface flake	Mbk	1	
TU-28-32	Flake fragment	Mbk	3		TU-28-32	Secondary flake	Mch	1	
TU-28-32	Biface flake	Mch	3		TU-28-32	Secondary flake	Ojcc-e	2	
TU-28-32	Biface flake	Ojcc-e	8		TU-28-32	Flake fragment	Ojcc-e	14	
TU-28-32	Primary flake	Ojcc-b	1		TU-28-32	Biface flake	Ojcc-b	6	
TU-28-32	Flake fragment	Ojcc-b	10		TU-28-32	Secondary flake	Ojcc-m	1	
TU-28-32	Flake fragment	Ojcc-m	2		TU-28-33	Biface flake	Mbk	4	
TU-28-33	Flake fragment	Mbk	1		TU-28-33	Secondary flake	Mch	1	
TU-28-33	Biface flake	Mch	3		TU-28-33	Flake fragment	Mch	4	
TU-28-33	Primary flake	Ojcc-e	1		TU-28-33	Secondary flake	Ojcc-e	3	
TU-28-33	Biface flake	Ojcc-e	17		TU-28-33	Flake fragment	Ojcc-e	21	
TU-28-33	Primary flake	Ojcc-b	6		TU-28-33	Tertiary flake	Ojcc-b	2	
TU-28-33	Biface flake	Ojcc-b	12		TU-28-33	Flake fragment	Ojcc-b	13	
TU-28-33	Tertiary flake	Ojcc-m	1		TU-28-33	Flake fragment	Ojcc-m	2	
TU-28-34A	Primary flake	Mch	1		TU-28-34A	Biface flake	Mch	2	
TU-28-34A	Secondary flake	Ojcc-e	1		TU-28-34A	Tertiary flake	Ojcc-e	1	
TU-28-34A	Biface flake	Ojcc-e	10		TU-28-34A	Flake fragment	Ojcc-e	15	
TU-28-34A	Secondary flake	Ojcc-b	2		TU-28-34A	Tertiary flake	Ojcc-b	1	
TU-28-34A	Biface flake	Ojcc-b	5		TU-28-34A	Flake fragment	Ojcc-b	9	
TU-28-34A	Flake fragment	Ojcc-m	1		TU-28-34A	Biface flake	Ojcc-o	1	
TU-28-34A	Primary flake	Ojcc-q	1		TU-28-34B	Flake fragment	Mbk	1	
TU-28-34B	Biface flake	Mch	3		TU-28-34B	Flake fragment	Mch	2	
TU-28-34B	Primary flake	Ojcc-e	1		TU-28-34B	Secondary flake	Ojcc-e	3	
TU-28-34B	Tertiary flake	Ojcc-e	1		TU-28-34B	Biface flake	Ojcc-e	6	
TU-28-34B	Flake fragment	Ojcc-e	18		TU-28-34B	Secondary flake	Ojcc-b	1	
TU-28-34B	Biface flake	Ojcc-b	3		TU-28-34B	Flake fragment	Ojcc-b	6	
TU-28-34B	Flake fragment	Ojcc-m	1		TU-28-35A	Biface flake	Mbk	1	
TU-28-35A	Primary flake	Ojcc-e	3		TU-28-35A	Biface flake	Ojcc-e	5	
TU-28-35A	Flake fragment	Ojcc-e	4		TU-28-35A	Biface flake	Ojcc-b	2	
TU-28-35A	Flake fragment	Ojcc-b	4		TU-28-35B	Biface flake	Mbk	1	
TU-28-35B	Flake fragment	Mbk	2		TU-28-35B	Flake fragment	Mch	1	
TU-28-35B	Primary flake	Ojcc-e	1		TU-28-35B	Secondary flake	Ojcc-e	2	
TU-28-35B	Biface flake	Ojcc-e	9		TU-28-35B	Flake fragment	Ojcc-e	7	
TU-28-35B	Flake fragment	Ojcc-b	2		TU-28-35B	Flake fragment	Ojcc-m	2	
TU-28-36	Flake fragment	Mch	3		TU-28-36	Secondary flake	Ojcc-e	2	
TU-28-36	Biface flake	Ojcc-e	6		TU-28-36	Flake fragment	Ojcc-e	8	
TU-28-36	Primary flake	Ojcc-b	1		TU-28-36	Biface flake	Ojcc-b	4	
TU-28-36	Flake fragment	Ojcc-b	5		TU-28-36	Biface flake	Ojcc-o	1	
TU-28-36A	Flake fragment	Mbk	2		TU-28-36A	Biface flake	Mch	1	
TU-28-36A	Secondary flake	Ojcc-e	1		TU-28-36A	Biface flake	Ojcc-e	1	
TU-28-36A	Flake fragment	Ojcc-e	6		TU-28-36A	Biface flake	Ojcc-b	1	
TU-28-36A	Biface flake	Ojcc-m	1		TU-29-30	Biface flake	Ojcc-e	5	

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-29-30	Flake fragment	Ojcc-e	1		TU-29-31	Biface flake	Mbk	1	
TU-29-31	Biface flake	Ojcc-e	1		TU-29-31	Flake fragment	Ojcc-e	5	
TU-29-31	Tertiary flake	Ojcc-b	1		TU-29-31	Biface flake	Ojcc-b	1	
TU-29-31	Flake fragment	Ojcc-b	2		TU-29-32	Primary flake	Mbk	1	
TU-29-32	Biface flake	Mch	1		TU-29-32	Flake fragment	Mch	1	
TU-29-32	Biface flake	Ojcc-e	5		TU-29-32	Flake fragment	Ojcc-e	8	
TU-29-32	Primary flake	Ojcc-b	1		TU-29-32	Secondary flake	Ojcc-b	2	
TU-29-32	Biface flake	Ojcc-b	3		TU-29-32	Flake fragment	Ojcc-b	4	
TU-29-32	Flake fragment	Ojcc-m	1		TU-29-33	Secondary flake	Mch	1	
TU-29-33	Biface flake	Mch	1		TU-29-33	Biface flake	Ojcc-e	1	
TU-29-33	Flake fragment	Ojcc-e	7		TU-29-33	Secondary flake	Ojcc-b	1	
TU-29-33	Flake fragment	Ojcc-b	4		TU-29-33	Flake fragment	Ojcc-m	1	
TU-29-34	Biface flake	Mbk	1		TU-29-34	Secondary flake	Mch	1	
TU-29-34	Biface flake	Mch	1		TU-29-34	Primary flake	Ojcc-e	1	
TU-29-34	Biface flake	Ojcc-e	6		TU-29-34	Flake fragment	Ojcc-e	16	
TU-29-34	Biface flake	Ojcc-b	7		TU-29-34	Flake fragment	Ojcc-b	3	
TU-29-34	Tested cobble	Ojcc-m	1		TU-29-34	Flake fragment	Ojcc-m	1	
TU-30-31B	Biface flake	Mpk	1	08LP	TU-30-31B	Secondary flake	Mbk	1	08LP
TU-30-31B	Flake fragment	Mbk	3	08LP	TU-30-31B	Flake fragment	Mch	1	08LP
TU-30-31B	Secondary flake	Ojcc-e	1	08LP	TU-30-31B	Biface flake	Ojcc-e	10	08LP
TU-30-31B	Flake fragment	Ojcc-e	15	08LP	TU-30-31B	Biface flake	Ojcc-b	12	08LP
TU-30-31B	Flake fragment	Ojcc-b	6	08LP	TU-30-32A	Flake fragment	Ojcc-e	2	08LP
TU-30-32A	Biface flake	Ojcc-q	1	08LP	TU-30-32B	Flake fragment	Ojcc-e	1	08LP
TU-31-30	Primary flake	Mch	1		TU-31-30	Biface flake	Mch	1	
TU-31-30	Biface flake	Ojcc-e	2		TU-31-30	Flake fragment	Ojcc-e	1	
TU-31-31	Biface flake	Mch	1		TU-31-31	Primary flake	Ojcc-e	1	
TU-31-31	Biface flake	Ojcc-e	1		TU-31-31	Flake fragment	Ojcc-e	2	
TU-31-31	Biface flake	Ojcc-b	2		TU-31-32	Biface flake	Mch	2	
TU-31-32	Flake fragment	Mch	2		TU-31-32	Primary flake	Ojcc-e	2	
TU-31-32	Secondary flake	Ojcc-e	2		TU-31-32	Biface flake	Ojcc-e	3	
TU-31-32	Flake fragment	Ojcc-e	12		TU-31-32	Secondary flake	Ojcc-b	1	
TU-31-32	Biface flake	Ojcc-b	1		TU-31-32	Flake fragment	Ojcc-b	2	
TU-31-32	Tertiary flake	Ojcc-m	1		TU-31-32	Flake fragment	Ojcc-m	2	
TU-31-33	Biface flake	Mbk	1		TU-31-33	Biface flake	Mch	2	
TU-31-33	Flake fragment	Mch	2		TU-31-33	Secondary flake	Ojcc-e	5	
TU-31-33	Tertiary flake	Ojcc-e	1		TU-31-33	Biface flake	Ojcc-e	4	
TU-31-33	Flake fragment	Ojcc-e	6		TU-31-33	Secondary flake	Ojcc-b	1	
TU-31-33	Biface flake	Ojcc-b	1		TU-31-33	Flake fragment	Ojcc-b	4	
TU-31-33	Biface flake	Ojcc-m	2		TU-31-33	Flake fragment	Ojcc-m	1	
TU-32-30	Biface flake	Mbk	1	08LP	TU-32-30	Flake fragment	Mbk	2	08LP
TU-32-30	Biface flake	Mch	4	08LP	TU-32-30	Flake fragment	Mch	6	08LP
TU-32-30	Primary flake	Ojcc-e	1	08LP	TU-32-30	Secondary flake	Ojcc-e	1	08LP
TU-32-30	Biface flake	Ojcc-e	6	08LP	TU-32-30	Flake fragment	Ojcc-e	7	08LP
TU-32-30	Primary flake	Ojcc-b	2	08LP	TU-32-30	Tertiary flake	Ojcc-b	1	08LP
TU-32-30	Flake fragment	Ojcc-b	3	08LP	TU-32-30	Biface flake	Ojcc-m	1	08LP
TU-32-30	Flake fragment	Ojcc-m	1	08LP	TU-32-30	Flake fragment	Ojcc-o	1	08LP
TU-32-31	Flake fragment	Mbk	2	08LP	TU-32-31	Secondary flake	Mch	3	08LP
TU-32-31	Biface flake	Mch	10	08LP	TU-32-31	Flake fragment	Mch	13	08LP
TU-32-31	Primary flake	Ojcc-e	1	08LP	TU-32-31	Secondary flake	Ojcc-e	1	08LP
TU-32-31	Biface flake	Ojcc-e	13	08LP	TU-32-31	Flake fragment	Ojcc-e	33	08LP
TU-32-31	Flake fragment	Ojcc-b	6	08LP	TU-32-31	Working core	Ojcc-o	1	08LP
TU-32-31	Flake fragment	Ojcc-o	1	08LP	TU-32-32	Tertiary flake	Mbk	1	08LP
TU-32-32	Flake fragment	Mbk	4	08LP	TU-32-32	Tertiary flake	Mch	2	08LP
TU-32-32	Biface flake	Mch	6	08LP	TU-32-32	Flake fragment	Mch	7	08LP
TU-32-32	Primary flake	Ojcc-e	2	08LP	TU-32-32	Secondary flake	Ojcc-e	3	08LP

Test-Unit and Miscellaneous Debitage Data.

Provenience	Type	Raw Material	N	Component	Provenience	Type	Raw Material	N	Component
TU-32-32	Tertiary flake	Ojcc-e	2	08LP	TU-32-32	Biface flake	Ojcc-e	6	08LP
TU-32-32	Flake fragment	Ojcc-e	17	08LP	TU-32-32	Secondary flake	Ojcc-b	2	08LP
TU-32-32	Tertiary flake	Ojcc-b	2	08LP	TU-32-32	Biface flake	Ojcc-b	4	08LP
TU-32-32	Flake fragment	Ojcc-m	2	08LP	TU-32-32	Secondary flake	Ojcc-q	1	08LP
TU-33-31A	Biface flake	Mch	1	08LP	TU-33-31A	Flake fragment	Mch	1	08LP
TU-33-31A	Primary flake	Ojcc-e	1	08LP	TU-33-31A	Secondary flake	Ojcc-e	1	08LP
TU-33-31A	Tertiary flake	Ojcc-e	2	08LP	TU-33-31A	Biface flake	Ojcc-e	3	08LP
TU-33-31A	Flake fragment	Ojcc-e	4	08LP	TU-33-31A	Biface flake	Ojcc-b	5	08LP
TU-33-31A	Flake fragment	Ojcc-b	2	08LP	TU-33-31A	Biface flake	Ojcc-m	1	08LP
TU-33-31A	Flake fragment	Ojcc-m	3	08LP	TU-33-31B	Biface flake	Mch	1	08LP
TU-33-31B	Primary flake	Ojcc-e	3	08LP	TU-33-31B	Secondary flake	Ojcc-e	1	08LP
TU-33-31B	Tertiary flake	Ojcc-e	1	08LP	TU-33-31B	Biface flake	Ojcc-e	3	08LP
TU-33-31B	Flake fragment	Ojcc-e	14	08LP	TU-33-31B	Biface flake	Ojcc-b	1	08LP
TU-33-31B	Flake fragment	Ojcc-b	4	08LP	TU-33-31B	Flake fragment	Ojcc-m	2	08LP
TU-33-32A	Tertiary flake	Ojcc-e	1	08LP	TU-33-32A	Biface flake	Ojcc-e	1	08LP
TU-33-32A	Flake fragment	Ojcc-e	2	08LP	TU-33-32A	Flake fragment	Ojcc-b	2	08LP
TU-33-32A	Primary flake	Ojcc-o	1	08LP	TU-33-32A	Biface flake	Ojcc-o	1	08LP
TU-33-32A	Flake fragment	Ojcc-o	4	08LP	TU-33-32B	Flake fragment	Ojcc-b	1	08LP
TU-34-31	Tested cobble	Mbk	1	08LP	TU-34-31	Primary flake	Mbk	7	08LP
TU-34-31	Secondary flake	Mbk	11	08LP	TU-34-31	Biface flake	Mbk	7	08LP
TU-34-31	Flake fragment	Mbk	21	08LP	TU-34-31	Primary flake	Ojcc-e	3	08LP
TU-34-31	Secondary flake	Ojcc-e	7	08LP	TU-34-31	Biface flake	Ojcc-e	27	08LP
TU-34-31	Flake fragment	Ojcc-e	34	08LP	TU-34-31	Flake fragment	Ojcc-b	2	08LP
TU-34-32A	Biface flake	Ojcc-e	1	08LP	TU-35-31	Biface flake	Mbk	1	08LP
TU-35-31	Flake fragment	Mbk	1	08LP	TU-35-31	Primary flake	Mch	1	08LP
TU-35-31	Primary flake	Ojcc-e	1	08LP	TU-35-31	Biface flake	Ojcc-e	2	08LP
TU-35-31	Flake fragment	Ojcc-e	8	08LP	TU-35-31	Flake fragment	Ojcc-b	5	08LP
TU-35-31	Tested cobble	Ojcc-m	1	08LP	TU-35-31	Secondary flake	Ojcc-m	1	08LP
TU-35-31	Biface flake	Ojcc-m	1	08LP	TU-35-31	Biface flake	Ojcc-q	1	08LP
TU-35-32A	Secondary flake	Mch	1	08LP	TU-35-32A	Secondary flake	Ojcc-e	1	08LP
TU-35-32A	Biface flake	Ojcc-e	1	08LP	TU-35-32A	Flake fragment	Ojcc-e	5	08LP
TU-35-32A	Secondary flake	Ojcc-b	2	08LP	TU-35-32A	Biface flake	Ojcc-b	5	08LP
TU-35-32A	Flake fragment	Ojcc-b	7	08LP	TU-35-32A	Tertiary flake	Ojcc-m	1	08LP
TU-35-32A	Biface flake	Ojcc-m	4	08LP	TU-35-32A	Flake fragment	Ojcc-m	5	08LP
TU-35-32A	Tertiary flake	Ojcc-q	1	08LP	TU-35-32B	Flake fragment	Mch	1	08LP
TU-35-32B	Secondary flake	Ojcc-e	1	08LP	TU-35-32B	Tertiary flake	Ojcc-e	1	08LP
TU-37-31A	Biface flake	Mch	1	08LP	TU-37-31A	Primary flake	Ojcc-e	3	08LP
TU-37-31A	Secondary flake	Ojcc-e	2	08LP	TU-37-31A	Tertiary flake	Ojcc-e	4	08LP
TU-37-31A	Biface flake	Ojcc-e	4	08LP	TU-37-31A	Flake fragment	Ojcc-e	1	08LP
TU-37-31A	Primary flake	Ojcc-b	1	08LP	TU-37-31A	Tertiary flake	Ojcc-b	1	08LP
TU-37-31A	Biface flake	Ojcc-b	2	08LP	TU-37-31A	Flake fragment	Ojcc-b	4	08LP
TU-37-31A	Secondary flake	Ojcc-m	3	08LP	TU-37-31A	Tertiary flake	Ojcc-m	1	08LP
TU-37-31A	Flake fragment	Ojcc-m	2	08LP	TU-37-31B	Tertiary flake	Ojcc-b	1	08LP
TU-37-31B	Flake fragment	Ojcc-m	2	08LP	TU-37-32	Primary flake	Ojcc-b	1	08LP
TU-37-32	Secondary flake	Ojcc-b	2	08LP					

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Alluvial	Indeterminate	Component
ATS-1.0-1.3	Mbk	2		2	2			03LA
ATS-1.5-1.6	Pw-bk	1		1		1		03LA
ATS-1.5-1.6	Mbk	1		1				03LA
ATS-1.6-1.7	Mbk	16	9	7	2	4		03LA
ATS-1.6-1.7	Ojcc-b	2		2	1			03LA
ATS-1.7-2.1	Mbk	32	12	20	9	7	2	04ELA
ATS-1.7-2.1	Ojcc-e	1		1	1			04ELA
ATS-2.1-2.4	Mbk	41	17	24	14	5	2	04ELA
ATS-2.1-2.4	Ojcc-e	1		1		1		04ELA
ATS-2.1-2.4	Ojcc-b	2		2	1	1		04ELA
ATS-2.3-2.4	Mbk	129	60	69	20	15	5	04ELA
ATS-2.3-2.4	Mch	2	2					04ELA
ATS-2.3-2.4	Ojcc-e	1		1				04ELA
ATS-2.3-2.4	Ojcc-b	2		2			1	04ELA
ATS-2.3-2.4	Ojcc-m	2	1	1				04ELA
ATS-2.3-2.4	Ojcc-o	1		1				04ELA
ATS-2.3-2.4	Pw-ch	1		1		1		04ELA
BTS-1.3-1.5	Mbk	3		3				05MA
BTS-1.3-1.5	Ojcc-b	1		1	1			05MA
BTS-1.5-1.8	Mbk	4		4				05MA
BTS-1.5-1.8	Ojcc-m	1		1		1		05MA
BTS-1.8-2.0	Mbk	3	1	2	3			06LEA
BTS-1.8-2.0	Mch	3	2	1	1			06LEA
BTS-1.8-2.0	Ojcc-o	1		1		1		06LEA
BTS-2.0-2.4	Mbk	5		5	2	1		06LEA
BTS-2.0-2.4	Mch	2		2		1		06LEA
BTS-2.0-2.4	Ojcc-b	1		1				06LEA
BTS-2.0-2.4	Ojcc-e	1		1				06LEA
BTS-2.4-2.6	Mbk	2		2		2		07EEA
BTS-2.4-2.6	Mch	2		2			1	07EEA
BTS-2.4-2.6	Ojcc-e	4		4		2		07EEA
BTS-2.4-2.6	Ojcc-b	4	1	3			1	07EEA
BTS-2.4-2.6	Ojcc-o	1		1				07EEA
BTS-2.6	Mbk	3	1	2				07EEA
BTS-2.6	Mch	2		2	1	1		07EEA
BTS-2.6	Ojcc-e	7		7		4		07EEA
BTS-2.6	Ojcc-b	3		3				07EEA
BTS-2.6	Ojcc-m	2	1	1				07EEA
ER-S/18	Mbk	1	1					
ER-S/19	Ojcc-e	1		1	1			
ER-S/20	Mbk	1		1		1		
F-01	Mbk	4		4		1		01WM
F-01	Ojcc-m	1		1		1		01WM
F-01	Ojcc-e	1		1		1		01WM
F-01	Mch	1	1			1		01WM
F-06	Mbk	4	1	3				01WM
F-07	Mbk	4	2	2		1		01WM
F-12	Mbk	1	1					01WM
F-15	Ojcc-e	4		4				01WM
F-16	Mbk	2		2				01WM
F-17	Mbk	1	1					03LA
F-18	Mbk	1	1					04ELA
F-18	Ojcc-e	2		2				04ELA
F-20	Mbk	9	4	5		1		04ELA
F-22	Mbk	1	1					04ELA
F-23	Ojcc-e	14		14		2		08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
F-23	Ojcc-e	19		19		6		08LP
F-23	Ojcc-e	5		5		2		08LP
F-23	Ojcc-e	5		5		2		08LP
F-23	Ojcc-e	3		3				08LP
F-24	Ojcc-e	24		24		4		08LP
F-24	Ojcc-e	92		92		8		08LP
F-26	Mch	4		4		1		08LP
F-26	Mch	3		3	1			08LP
F-26	Ojcc-e	25		25		10		08LP
F-26	Ojcc-e	9		9				08LP
F-26	Ojcc-e	7		7		5		08LP
F-26	Ojcc-e	4		4				08LP
F-26	Ojcc-e	2		2				08LP
F-26	Ojcc-e	3		3		3		08LP
F-26	Ojcc-e	3		3		3		08LP
F-26	Ojcc-b	7		7		3		08LP
F-26	Ojcc-b	7		7		2		08LP
F-26	Ojcc-b	3		3				08LP
F-26	Ojcc-e	15		15		5		08LP
F-26	Ojcc-b	2		2		2		08LP
F-27	Ojcc-e	21		21		4		08LP
F-28	Mbk	13		13		1		08LP
F-28	Mbk	20		20	3			08LP
F-28	Mbk	15		15		6		08LP
F-28	Mbk	33		33		15		08LP
F-28	Mch	5		5				08LP
F-28	Mch	11		11	3			08LP
F-28	Mch	2		2		2		08LP
F-28	Mch	53		53		1		08LP
F-28	Mch	104	1	103	4	5		08LP
F-28	Ojcc-b	12		12	1			08LP
F-28	Ojcc-b	2		2	2			08LP
F-28	Ojcc-b	6		6				08LP
F-28	Ojcc-b	4		4				08LP
F-28	Ojcc-b	3		3				08LP
F-28	Ojcc-b	2		2		1		08LP
F-28	Ojcc-b	2		2				08LP
F-28	Ojcc-b	2		2	1			08LP
F-28	Ojcc-b	2		2				08LP
F-28	Ojcc-b	2		2				08LP
F-28	Ojcc-b	4		4		3		08LP
F-28	Ojcc-b	2		2				08LP
F-28	Ojcc-b	2		2	2			08LP
F-28	Ojcc-b	2		2				08LP
F-28	Ojcc-b	492	4	488	20	28	4	08LP
F-28	Ojcc-e	4		4				08LP
F-28	Ojcc-e	2		2		1		08LP
F-28	Ojcc-e	2		2				08LP
F-28	Ojcc-e	2		2		2		08LP
F-28	Ojcc-e	6		6	5			08LP
F-28	Ojcc-e	7		7				08LP
F-28	Ojcc-e	2		2		1		08LP
F-28	Ojcc-e	62		62				08LP
F-28	Ojcc-e	2		2				08LP
F-28	Ojcc-e	14		14	5			08LP
F-28	Ojcc-e	6		6	3			08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
F-28	Ojcc-e	2		2		2		08LP
F-28	Ojcc-e	3		3		3		08LP
F-28	Ojcc-e	2		2		1		08LP
F-28	Ojcc-e	2		2		2		08LP
F-28	Ojcc-e	2		2		2		08LP
F-28	Ojcc-e	2		2				08LP
F-28	Ojcc-e	3		3	3			08LP
F-28	Ojcc-e	3		3	2			08LP
F-28	Ojcc-e	279		279	3	47	1	08LP
F-28	Ojcc-m	2		2		2		08LP
F-28	Ojcc-m	12		12		2		08LP
F-28	Ojcc-m	32		32	5			08LP
F-28	Ojcc-m	3		3				08LP
F-28	Ojcc-m	2		2				08LP
F-28	Ojcc-m	121		121		7		08LP
F-28	Ojcc-o	4		4		1		08LP
F-28	Ojcc-q	1		1	1			08LP
F-28	Ojcc-b	8		8		2		08LP
F-29	Ojcc-b	18		18	1			08LP
F-29	Ojcc-b	16		16	3			08LP
F-29	Ojcc-b	2		2	1			08LP
F-29	Ojcc-e	3		3		2		08LP
F-29	Ojcc-e	2		2				08LP
F-29	Ojcc-e	2		2				08LP
F-29	Ojcc-e	2		2		1		08LP
F-29	Ojcc-e	3		3		1		08LP
F-29	Mbk	2		2		1		08LP
F-29	Mch	1		1				08LP
F-29	Ojcc-b	13		13	1	1		08LP
F-29	Ojcc-e	27		27	2	6	1	08LP
F-29	Ojcc-m	17		17		1		08LP
F-29	Ojcc-b	3		3				08LP
F-29	Ojcc-e	1		1		1		08LP
F-29	Ojcc-e	1		1				08LP
F-30	Mbk	3	1	2	1			04ELA
F-31	Mbk	1		1	1			04ELA
F-32	Mbk	2		2				08LP
F-32	Ojcc-b	2		2		2		08LP
F-32	Ojcc-b	2		2				08LP
F-32	Ojcc-e	41		41		6		08LP
F-32	Ojcc-m	2		2		2		08LP
F-32	Mbk	1		1				08LP
F-32	Ojcc-m	14		14		9		08LP
F-33	Mbk	3		3				08LP
F-33	Ojcc-b	15		15		1		08LP
F-33	Ojcc-e	7		7		4		08LP
F-33	Ojcc-e	8		8		4		08LP
F-33	Ojcc-e	2		2		2		08LP
F-33	Ojcc-e	4		4				08LP
F-33	Ojcc-m	11		11				08LP
F-33	Ojcc-m	2		2		1		08LP
F-33	Mbk	3		3		1		08LP
F-33	Mch	3		3	1			08LP
F-33	Ojcc-b	8		8				08LP
F-33	Ojcc-e	44		44		9		08LP
F-33	Ojcc-m	8		8		1		08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
F-36	Ojcc-e	11		11		6		08LP
F-36	Ojcc-e	4		4				08LP
F-36	Ojcc-e	4		4				08LP
F-36	Ojcc-e	3		3				08LP
F-36	Ojcc-e	2		2		2		08LP
F-36	Ojcc-e	2		2				08LP
F-36	Mbk	4		4			1	08LP
F-36	Ojcc-e	3		3		2		08LP
F-36	Mbk	1		1		1		08LP
F-38	Ojcc-e	20		20	2			08LP
F-38	Ojcc-e	11		11		9		08LP
F-38	Ojcc-e	13		13		2		08LP
F-38	Ojcc-e	7		7				08LP
F-38	Ojcc-e	8		8				08LP
F-38	Ojcc-e	5		5				08LP
F-38	Ojcc-e	5		5				08LP
F-38	Ojcc-e	5		5		1		08LP
F-38	Ojcc-e	4		4	1			08LP
F-38	Ojcc-e	6		6				08LP
F-38	Ojcc-e	2		2		2		08LP
F-38	Ojcc-e	2		2				08LP
F-38	Ojcc-e	2		2				08LP
F-38	Ojcc-e	2		2				08LP
F-38	Ojcc-e	2		2				08LP
F-38	Ojcc-e	96		96	4	17	1	08LP
F-38	Ojcc-m	2		2		1		08LP
F-40	Mch	278		278	14			08LP
F-41	Ojcc-e	33		33		11		08LP
F-42	Ojcc-e	52		52		34		08LP
F-42	Ojcc-e	48		48				08LP
F-42	Ojcc-b	25		25				08LP
F-43	Ojcc-e	58		58		5		08LP
F-44	Ojcc-e	66		66		15		08LP
F-45	Ojcc-e	6		6				08LP
F-45	Ojcc-b	5		5				08LP
F-45	Ojcc-b	3		3				08LP
PZBD	Mbk	54	15	39	6	8	2	01WM
PZBD	Mch	3	1	2	1			01WM
PZBD	Ojcc-e	9	3	6	1	4		01WM
PZBD	Ojcc-b	2		2	1			01WM
PZBD	Ojcc-m	1		1				01WM
T-1b/T-1c	Pw-bk	2		2		2		022WLA
T-1b/T-1c	Mbk	64	22	42	2	4	1	022WLA
T-1b/T-1c	Mch	3		3				022WLA
T-1b/T-1c	Ojcc-e	11	3	8		1	1	022WLA
T-1b/T-1c	Ojcc-b	8		8				022WLA
T-1b/T-1c	Ojcc-m	3	1	2				022WLA
T-1b/T-1c	Ojcc-o	1		1				022WLA
TU-01	Ojcc-e	1		1				021W
TU-01	Ojcc-o	1		1		1		021W
TU-01	Mbk	2	2					021W
TU-01	Ojcc-m	1		1				021W
TU-01	Mch	1		1		1		021W
TU-01	Ojcc-e	1		1				021W
TU-01	Mbk	1	1					021W
TU-02-11	Mbk	4	1	3				03LA

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Alluvial	Indeterminate	Component
TU-02-11	Ojcc-m	3		3				03LA
TU-02-12	Mbk	2		2				03LA
TU-02-13	Mbk	2	1	1				03LA
TU-02-13	Ojcc-o	1		1				03LA
TU-02-14	Mbk	2		2	1			03LA
TU-02-15	Mbk	2	1	1				03LA
TU-03-18	Mbk	2	1	1				06LEA
TU-03-19	Mbk	2		2			1	06LEA
TU-03-21	Mbk	1		1				06LEA
TU-03-22	Mbk	1		1			1	06LEA
TU-03-23	Mch	1	1					06LEA
TU-03-23	Ojcc-b	1		1				06LEA
TU-04-26	Mbk	5	1	4		1		07EEA
TU-04-26	Mch	4		4				07EEA
TU-04-26	Ojcc-m	4		4				07EEA
TU-04-26	Ojcc-b	5		5				07EEA
TU-04-26	Ojcc-e	5		5		2	1	07EEA
TU-04-27	Mch	6		6		1		07EEA
TU-04-27	Ojcc-m	2	2					07EEA
TU-04-27	Ojcc-b	11		11				07EEA
TU-04-27	Ojcc-o	5		5			1	07EEA
TU-04-27	Ojcc-e	8	1	7		1	1	07EEA
TU-04-28	Mbk	4		4		1		07EEA
TU-04-28	Mch	3		3				07EEA
TU-04-28	Ojcc-m	10		10			1	07EEA
TU-04-28	Ojcc-b	6		6	1			07EEA
TU-04-28	Ojcc-e	11	1	10				07EEA
TU-04-28	Ojcc-q	1		1				07EEA
TU-04-29	Mbk	11	2	9				
TU-04-29	Mrs	1		1				
TU-04-29	Mch	2		2				
TU-04-29	Ojcc-e	22	1	21		5	1	
TU-04-29	Ojcc-b	45	1	44	2	3	1	
TU-04-29	Ojcc-m	3	1	2		1		
TU-04-29	Ojcc-c	1		1		1		
TU-04-30	Mbk	10	1	9		1		08LP
TU-04-30	Mch	5		5				08LP
TU-04-30	Ojcc-e	79	1	78		9		08LP
TU-04-30	Ojcc-b	120	1	119	2	3		08LP
TU-04-30	Ojcc-m	9	1	8				08LP
TU-04-31	Mbk	11		11		2		08LP
TU-04-31	Mch	8		8		1		08LP
TU-04-31	Ojcc-m	8		8				08LP
TU-04-31	Ojcc-b	15		15				08LP
TU-04-31	Ojcc-o	3		3				08LP
TU-04-31	Ojcc-e	70	1	69		11		08LP
TU-04-32	Mbk	9		9		1		08LP
TU-04-32	Mch	3		3				08LP
TU-04-32	Ojcc-e	24		24		1		08LP
TU-04-32	Ojcc-b	7		7				08LP
TU-04-32	Ojcc-m	2		2				08LP
TU-04-32	Ojcc-q	1		1				08LP
TU-04-33	Ojcc-b	1	1					09EP
TU-04-35	Mbk	1		1		1		09EP
TU-04-36	Mbk	1		1		1		09EP
TU-04-37	Ojcc-b	1		1			1	09EP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-04-SW-26	Ojcc-m	3		3				07EEA
TU-04-SW-26	Ojcc-o	1		1				07EEA
TU-04-SW-26	Ojcc-e	2	1	1		2		07EEA
TU-04-SW-27	Mbk	3		3		1		07EEA
TU-04-SW-27	Ojcc-m	6		6		1		07EEA
TU-04-SW-27	Ojcc-b	5		5				07EEA
TU-04-SW-27	Ojcc-e	8	1	7		1		07EEA
TU-04-SW-27	Ojcc-c	1		1				07EEA
TU-04-SW-28	Mbk	2		2				07EEA
TU-04-SW-28	Ojcc-m	12	1	11		1	1	07EEA
TU-04-SW-28	Ojcc-b	5	1	4				07EEA
TU-04-SW-28	Ojcc-e	8		8		1		07EEA
TU-04-SW-29	Mbk	4		4				
TU-04-SW-29	Mch	2	1	1		1		
TU-04-SW-29	Ojcc-m	6	1	5		3		
TU-04-SW-29	Ojcc-b	11		11				
TU-04-SW-29	Ojcc-e	12		12		2	1	
TU-04-SW-30	Mbk	14	3	11		1		08LP
TU-04-SW-30	Mch	7	1	6		1		08LP
TU-04-SW-30	Ojcc-m	36	2	34	1	2		08LP
TU-04-SW-30	Ojcc-b	62	5	57	2	2	1	08LP
TU-04-SW-30	Ojcc-e	120	22	98		23	4	08LP
TU-04-SW-30	Ojcc-o	5	1	4				08LP
TU-04-SW-31	Mbk	8		8				08LP
TU-04-SW-31	Mch	12	1	11				08LP
TU-04-SW-31	Ojcc-m	13		13		2		08LP
TU-04-SW-31	Ojcc-b	9		9				08LP
TU-04-SW-31	Ojcc-o	1		1				08LP
TU-04-SW-31	Ojcc-e	104	2	102	1	9	1	08LP
TU-04-SW-32	Ojcc-m	1		1				08LP
TU-04-SW-32	Ojcc-b	1		1				08LP
TU-04-SW-32	Ojcc-e	4		4		1		08LP
TU-05-24	Mbk	62	33	29	7	4	3	04ELA
TU-05-24	Ojcc-m	5	1	4			1	04ELA
TU-05-24	Ojcc-o	3	1	2	1	1		04ELA
TU-05-24	Ojcc-e	1		1				04ELA
TU-05-25	Mbk	57	28	29	12	3		04ELA
TU-05-25	Ojcc-e	2		2				04ELA
TU-05-25	Ojcc-b	1	1					04ELA
TU-05-26	Mbk	4	1	3	1			04ELA
TU-05-SW-24	Mbk	109	63	46	17	10	3	04ELA
TU-05-SW-24	Ojcc-m	2		2				04ELA
TU-05-SW-25	Mbk	82	56	26	2	4	1	04ELA
TU-05-SW-25	Ojcc-m	1		1			1	04ELA
TU-05-SW-26	Mbk	6	5	1		1	1	04ELA
TU-06	Mbk	27	5	22	5	3	2	022WLA
TU-06	Mch	1		1		1		022WLA
TU-06	Mbk	5		5	1			022WLA
TU-06	Mch	1		1	1			022WLA
TU-06-37	Ojcc-m	2		2	1			022WLA
TU-06-37	Ojcc-b	1		1				022WLA
TU-06-37	Ojcc-q	1	1					022WLA
TU-08-26	Mpk	1		1				07EEA
TU-08-26	Mbk	2		2		2		07EEA
TU-08-26	Mch	6		6				07EEA
TU-08-26	Ojcc-e	9		9		2		07EEA

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Alluvial	Indeterminate	Component
TU-08-26	Ojcc-b	5		5	1	1		07EEA
TU-08-26	Ojcc-m	1		1			1	07EEA
TU-08-27	Mbk	3		3				07EEA
TU-08-27	Mch	3	1	2				07EEA
TU-08-27	Ojcc-e	18		18	1	9		07EEA
TU-08-27	Ojcc-b	8		8		1		07EEA
TU-08-27	Ojcc-q	2		2		1		07EEA
TU-08-28	Mbk	2		2				07EEA
TU-08-28	Mch	8		8		1		07EEA
TU-08-28	Ojcc-e	25		25		8	1	07EEA
TU-08-28	Ojcc-b	4		4	1	2		07EEA
TU-08-28	Ojcc-q	5		5				07EEA
TU-08-28	Ojcc-m	1		1				07EEA
TU-08-28	Ojcc-o	1		1				07EEA
TU-08-29	Mbk	1		1				
TU-08-29	Mch	5	1	4	2	2	1	
TU-08-29	Ojcc-e	31	1	30		11		
TU-08-29	Ojcc-b	20		20		2	1	
TU-08-29	Ojcc-q	1		1				
TU-08-30	Mbk	8		8				08LP
TU-08-30	Mch	5		5				08LP
TU-08-30	Ojcc-e	60		60	1	7	1	08LP
TU-08-30	Ojcc-b	20		20		2		08LP
TU-08-30	Ojcc-q	7		7				08LP
TU-08-30	Ojcc-m	3		3				08LP
TU-08-30	Ojcc-o	1		1				08LP
TU-08-31	Mbk	7	2	5				08LP
TU-08-31	Mch	4		4			1	08LP
TU-08-31	Ojcc-e	87		87		6	1	08LP
TU-08-31	Ojcc-b	22		22	1			08LP
TU-08-31	Ojcc-q	11		11				08LP
TU-08-31	Ojcc-m	1		1				08LP
TU-08-31	Ex	1		1				08LP
TU-08-32	Mbk	4	2	2				08LP
TU-08-32	Mch	2		2		1		08LP
TU-08-32	Ojcc-e	21		21		2		08LP
TU-08-32	Ojcc-b	5		5				08LP
TU-08-32	Ojcc-q	2		2				08LP
TU-08-32	Ojcc-m	3		3				08LP
TU-08-33	Mbk	2		2				09EP
TU-08-33	Mch	1		1				09EP
TU-08-33	Ojcc-e	10		10		3		09EP
TU-08-33	Ojcc-b	2		2				09EP
TU-08-33	Ojcc-q	1		1				09EP
TU-08-SW-30	Mbk	7		7		1		08LP
TU-08-SW-30	Mch	2		2				08LP
TU-08-SW-30	Ojcc-e	42		42		3		08LP
TU-08-SW-30	Ojcc-b	48	1	47			1	08LP
TU-08-SW-30	Ojcc-q	3		3		1		08LP
TU-08-SW-30	Ojcc-o	1		1				08LP
TU-08-SW-31	Mbk	2		2				08LP
TU-08-SW-31	Mch	3		3				08LP
TU-08-SW-31	Ojcc-e	39		39		1		08LP
TU-08-SW-31	Ojcc-b	25		25	2			08LP
TU-08-SW-31	Ojcc-q	12		12				08LP
TU-08-SW-31	Ojcc-m	2		2				08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Alluvial	Indeterminate	Component
TU-09-24	Mbk	19	11	8	1			04ELA
TU-09-24	Ojcc-e	1		1		1		04ELA
TU-09-25	Mbk	14	7	7	1	3		04ELA
TU-09-26	Mbk	4	2	2	2			04ELA
TU-10-25	Ojcc-e	2		2		1		07EEA
TU-10-26	Ojcc-e	1		1				07EEA
TU-10-27	Ojcc-e	1		1				07EEA
TU-10-28	Mbk	2		2				07EEA
TU-10-28	Ojcc-e	3		3		1		07EEA
TU-10-28	Ojcc-b	3		3				07EEA
TU-10-28	Ojcc-o	1		1				07EEA
TU-10-29	Mbk	1		1				
TU-10-29	Ojcc-e	6		6		1		
TU-10-29	Ojcc-b	2		2				
TU-10-30	Mbk	5		5		1		08LP
TU-10-30	Mrs-1	1		1				08LP
TU-10-30	Mch	1	1					08LP
TU-10-30	Ojcc-e	19		19		2		08LP
TU-10-30	Ojcc-b	2		2				08LP
TU-10-30	Ojcc-m	2		2				08LP
TU-10-31	Mch	2		2				08LP
TU-10-31	Ojcc-e	14	1	13		1		08LP
TU-10-31	Ojcc-b	10		10		1		08LP
TU-10-31	Ojcc-q	1		1				08LP
TU-10-31	Ojcc-m	2		2				08LP
TU-10-32	Mrs-1	1		1				08LP
TU-10-32	Ojcc-e	49		49		6	1	08LP
TU-10-32	Ojcc-b	5		5				08LP
TU-10-32	Ojcc-m	14		14				08LP
TU-10-32	Mbk	1		1				08LP
TU-10-33	Mbk	1		1				
TU-10-33	Ojcc-m	1		1				
TU-10-34	Ojcc-e	1		1				
TU-11-26	Mbk	1		1				07EEA
TU-11-26	Ojcc-e	2		2		2		07EEA
TU-11-26	Ojcc-b	2		2				07EEA
TU-11-26	Ojcc-o	1	1					07EEA
TU-11-27	Mbk	1		1				07EEA
TU-11-27	Ojcc-e	4		4		3	1	07EEA
TU-11-27	Ojcc-b	2		2	1			07EEA
TU-11-27	Ojcc-m	1		1		1		07EEA
TU-11-28	Mpk	1		1				07EEA
TU-11-28	Mbk	1		1				07EEA
TU-11-28	Ojcc-e	2		2		1		07EEA
TU-11-28	Ojcc-b	5		5	1			07EEA
TU-11-28	Ojcc-o	1		1				07EEA
TU-11-29	Mch	2		2				
TU-11-29	Ojcc-e	8		8		2		
TU-11-29	Ojcc-b	7		7	1	3		
TU-11-30	Mpk	2		2				08LP
TU-11-30	Mbk	2		2				08LP
TU-11-30	Mch	2		2				08LP
TU-11-30	Ojcc-e	61	2	59	1	3		08LP
TU-11-30	Ojcc-b	13		13		2	1	08LP
TU-11-30	Ojcc-o	2		2				08LP
TU-11-30	Ojcc-q	1		1				08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-11-31	Mpk	6		6				08LP
TU-11-31	Mbk	2		2				08LP
TU-11-31	Ojcc-e	29		29		1		08LP
TU-11-31	Ojcc-b	2		2				08LP
TU-11-31	Ojcc-o	2		2				08LP
TU-11-31	Ojcc-q	1		1				08LP
TU-11-32	Mpk	1		1				08LP
TU-11-32	Ojcc-e	8		8				08LP
TU-11-32	Ojcc-b	7		7	1			08LP
TU-11-32	Ojcc-o	1		1			1	08LP
TU-12-26	Mbk	1		1				07EEA
TU-12-26	Ojcc-e	4		4		2		07EEA
TU-12-27	Ojcc-e	3		3				07EEA
TU-12-27	Ojcc-b	5		5				07EEA
TU-12-27	Ojcc-m	2		2				07EEA
TU-12-28	Mch	1		1				07EEA
TU-12-28	Ojcc-e	10		10		4		07EEA
TU-12-28	Ojcc-b	6		6				07EEA
TU-12-28	Ojcc-m	2		2				07EEA
TU-12-28	Ojcc-c	1		1		1		07EEA
TU-12-29	Mbk	5		5				
TU-12-29	Mch	3		3				
TU-12-29	Ojcc-e	41	2	39		5	1	
TU-12-29	Ojcc-b	40		40		1	1	
TU-12-29	Ojcc-m	4		4				
TU-12-29	Ojcc-o	1		1				
TU-12-29	Ojcc-c	4		4				
TU-12-30	Mbk	8	3	5				08LP
TU-12-30	Mch	20	1	19	1	1	1	08LP
TU-12-30	Ojcc-e	144		144		19	1	08LP
TU-12-30	Ojcc-b	117		117	5	5	4	08LP
TU-12-30	Ojcc-m	19		19		1	2	08LP
TU-12-30	Ojcc-c	5		5				08LP
TU-12-31	Mbk	12	2	10		1		08LP
TU-12-31	Mch	7		7				08LP
TU-12-31	Ojcc-e	129	1	128		17	4	08LP
TU-12-31	Ojcc-b	77		77		3		08LP
TU-12-31	Ojcc-m	5		5		2		08LP
TU-12-31	Ex	1		1				08LP
TU-12-32	Mbk	2		2				08LP
TU-12-32	Mch	2		2				08LP
TU-12-32	Ojcc-e	20		20		3	1	08LP
TU-12-32	Ojcc-b	4		4				08LP
TU-12-32	Ojcc-m	2		2			2	08LP
TU-12-33A	Ojcc-b	1		1		1		09EP
TU-12-33B	Ojcc-e	1		1				09EP
TU-12-34A	Mbk	1		1		1		09EP
TU-12-35A	Ojcc-e	3		3				09EP
TU-12-35B	Mbk	1		1				09EP
TU-12-35B	Ojcc-e	1		1				09EP
TU-13-30	Mbk	3		3		1		08LP
TU-13-30	Mch	8	1	7				08LP
TU-13-30	Ojcc-e	82	3	79		6		08LP
TU-13-30	Ojcc-b	28		28		1		08LP
TU-13-30	Ojcc-m	4		4		2		08LP
TU-13-31	Mch	4		4	2	2		08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-13-31	Ojcc-e	58		58		4	2	08LP
TU-13-31	Ojcc-b	24		24		3		08LP
TU-13-31	Ojcc-m	2		2		1		08LP
TU-13-32A	Ojcc-e	3		3				08LP
TU-13-32B	Ojcc-e	8		8		2		08LP
TU-13-33A	Ojcc-e	3		3				09EP
TU-13-33A	Ojcc-b	1		1				09EP
TU-13-34A	Ojcc-e	2		2				09EP
TU-13-35	Ojcc-e	1		1				09EP
TU-14-30	Mbk	2		2				08LP
TU-14-30	Mch	6		6			1	08LP
TU-14-30	Ojcc-e	29		29		2		08LP
TU-14-30	Ojcc-b	71		71		1	1	08LP
TU-14-30	Ojcc-m	5		5				08LP
TU-14-30	Ojcc-q	1		1		1		08LP
TU-14-30	Ojcc-o	4		4				08LP
TU-14-31	Mpk	5		5				08LP
TU-14-31	Mbk	2		2				08LP
TU-14-31	Ojcc-e	17		17		3		08LP
TU-14-31	Ojcc-b	2		2				08LP
TU-14-31	Ojcc-o	2		2				08LP
TU-14-31	Ojcc-m	2		2				08LP
TU-15-30	Mbk	25		25	3		1	08LP
TU-15-30	Mch	2		2				08LP
TU-15-30	Ojcc-e	67	1	66	1	5		08LP
TU-15-30	Ojcc-b	4		4			1	08LP
TU-15-30	Ojcc-m	2		2				08LP
TU-15-30	Ojcc-o	4		4				08LP
TU-15-30	Ojcc-q	1		1				08LP
TU-15-31	Mbk	2		2				08LP
TU-15-31	Ojcc-e	4		4				08LP
TU-15-31	Ojcc-b	2		2			1	08LP
TU-15-33A	Ojcc-e	2		2		1		09EP
TU-15-33A	Ojcc-m	1		1				09EP
TU-15-34	Ojcc-e	1		1				09EP
TU-16-30	Mbk	2		2				08LP
TU-16-30	Mch	2		2		1		08LP
TU-16-30	Ojcc-e	33		33		4		08LP
TU-16-30	Ojcc-b	4		4				08LP
TU-16-30	Ojcc-c	1		1		1		08LP
TU-16-31	Mpk	1		1				08LP
TU-16-31	Mp-r	1		1				08LP
TU-16-31	Ojcc-e	9		9				08LP
TU-16-31	Ojcc-b	2		2				08LP
TU-16-32A	Ojcc-e	1		1		1		08LP
TU-16-34A	Ojcc-b	1		1				09EP
TU-16-34A	Ojcc-q	1		1	1			09EP
TU-16-35	Mch	1		1		1		09EP
TU-17-29	Mbk	2	1	1		1		
TU-17-29	Mch	2		2				
TU-17-29	Ojcc-e	9		9		4		
TU-17-29	Ojcc-b	1		1				
TU-17-29	Ojcc-m	2		2				
TU-17-30	Mbk	2	1	1				08LP
TU-17-30	Mch	1		1				08LP
TU-17-30	Ojcc-e	6		6		1		08LP

Debitage Attribute Data.

					Cortex Type			
Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Residual	Alluvial	Indeterminate	Component
TU-17-30	Ojcc-b	6		6				08LP
TU-17-31	Mbk	5		5		2	1	08LP
TU-17-31	Mch	3		3		1		08LP
TU-17-31	Ojcc-e	17		17		2		08LP
TU-17-31	Ojcc-b	9		9				08LP
TU-17-31	Ojcc-m	1		1				08LP
TU-17-32A	Ojcc-e	2		2		2		08LP
TU-17-32A	Ojcc-b	1		1				08LP
TU-17-32A	Ojcc-q	1		1				08LP
TU-17-32B	Ojcc-e	2		2				08LP
TU-17-33A	Ojcc-e	3		3		1		09EP
TU-17-33A	Ojcc-b	2		2				09EP
TU-17-33B	Ojcc-e	1		1		1		09EP
TU-17-33B	Ex	1		1				09EP
TU-18-30	Mbk	3		3				08LP
TU-18-30	Mch	2		2				08LP
TU-18-30	Ojcc-e	25		25		1		08LP
TU-18-30	Ojcc-b	12		12		4		08LP
TU-18-30	Ojcc-m	1		1				08LP
TU-18-30	Ex	1		1				08LP
TU-18-31	Ojcc-e	3		3				08LP
TU-18-31	Ojcc-b	2		2				08LP
TU-18-31	Ojcc-o	1		1				08LP
TU-18-32	Ojcc-e	2		2		1		08LP
TU-19-30	Mpk	1		1				08LP
TU-19-30	Mbk	5		5				08LP
TU-19-30	Mch	4		4				08LP
TU-19-30	Ojcc-e	73		73	1	12	1	08LP
TU-19-30	Ojcc-b	36		36	1		2	08LP
TU-19-30	Ojcc-o	39		39		5	1	08LP
TU-19-30	Ojcc-m	3		3				08LP
TU-19-31	Mch	1		1				08LP
TU-19-31	Ojcc-e	3		3		1		08LP
TU-19-31	Ojcc-b	1		1				08LP
TU-19-31	Ojcc-o	3		3				08LP
TU-19-31	Ojcc-m	1		1				08LP
TU-20-30	Ojcc-e	17		17	1	1		08LP
TU-20-30	Ojcc-b	15		15				08LP
TU-20-30	Ojcc-o	5		5	1			08LP
TU-20-31	Ojcc-e	2		2	2			08LP
TU-20-31	Ojcc-b	1		1				08LP
TU-20-31	Ojcc-m	1		1				08LP
TU-21-29	Mbk	6		6				
TU-21-29	Mch	3		3			1	
TU-21-29	Ojcc-e	20		20	1	2		
TU-21-29	Ojcc-b	43	1	42	2	4	2	
TU-21-29	Ojcc-m	8		8				
TU-21-30	Mbk	14		14		1		08LP
TU-21-30	Mch	11		11		2		08LP
TU-21-30	Ojcc-e	130	1	129	1	7	2	08LP
TU-21-30	Ojcc-b	146	1	145	2	7	1	08LP
TU-21-30	Ojcc-m	10		10				08LP
TU-21-30	Ojcc-o	2		2				08LP
TU-21-31	Mbk	28		28		1		08LP
TU-21-31	Mch	60	2	58	1	4		08LP
TU-21-31	Ojcc-e	171	2	169	4	15	3	08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-21-31	Ojcc-b	63	1	62		6	1	08LP
TU-21-32	Mbk	3	1	2				08LP
TU-21-32	Ojcc-e	15	1	14				08LP
TU-21-32	Ojcc-b	2		2				08LP
TU-21-33A	Ojcc-b	1		1				09EP
TU-21-34B	Ojcc-e	1		1		1		09EP
TU-21-34B	Ojcc-b	1		1				09EP
TU-22-29B	Mch	1		1			1	
TU-22-29B	Ojcc-b	6		6			1	
TU-22-30	Mbk	10		10		1		08LP
TU-22-30	Mch	22		22	2	2		08LP
TU-22-30	Ojcc-e	82		82	1	7	4	08LP
TU-22-30	Ojcc-b	131		131	2	3	3	08LP
TU-22-30	Ojcc-m	1		1				08LP
TU-22-30	Ojcc-c	1		1				08LP
TU-22-31	Mbk	8	1	7		3		08LP
TU-22-31	Mch	36		36	1	8	1	08LP
TU-22-31	Ojcc-e	77		77	1	10	1	08LP
TU-22-31	Ojcc-b	168		168	1	4	4	08LP
TU-22-31	Ojcc-o	1		1			1	08LP
TU-22-31	Ojcc-m	3		3				08LP
TU-22-32	Mbk	7		7				08LP
TU-22-32	Mch	56		56		9		08LP
TU-22-32	Ojcc-e	81	1	80		11	2	08LP
TU-22-32	Ojcc-b	66		66	1	8		08LP
TU-22-32	Ojcc-o	5	1	4		1		08LP
TU-22-33	Mch	4		4		1		09EP
TU-22-33	Ojcc-e	24		24		7	1	09EP
TU-22-33	Ojcc-b	7		7		1	1	09EP
TU-22-33	Ojcc-o	2		2		2		09EP
TU-22-34	Mch	1		1				09EP
TU-22-34	Ojcc-e	3		3		1		09EP
TU-22-34	Ojcc-b	1		1				09EP
TU-22-35B	Ojcc-e	2		2				09EP
TU-23-29B	Mch	1		1				
TU-23-29B	Ojcc-e	1		1				
TU-23-30	Mbk	3		3				
TU-23-30	Mch	7		7		1		
TU-23-30	Ojcc-e	8		8		1	1	
TU-23-30	Ojcc-b	13		13	1	2		
TU-23-31	Mbk	1		1				
TU-23-31	Mch	4		4				
TU-23-31	Ojcc-e	16		16		1		
TU-23-31	Ojcc-b	20		20		1	1	
TU-23-31	Ojcc-m	1		1		1		
TU-23-32A	Mch	4		4				
TU-23-32A	Ojcc-e	9		9				
TU-23-32A	Ojcc-b	11		11				
TU-23-32B	Mbk	1		1				
TU-23-32B	Mch	4		4				
TU-23-32B	Ojcc-e	13		13		2		
TU-23-32B	Ojcc-b	10		10		5		
TU-23-32B	Ojcc-m	1		1				
TU-23-33A	Mch	54		54	6		1	
TU-23-33A	Ojcc-e	32		32		8		
TU-23-33A	Ojcc-b	9		9		1		

Debitage Attribute Data.

					Cortex Type			
Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Residual	Alluvial	Indeterminate	Component
TU-23-33B	Mch	18		18		2	1	
TU-23-33B	Ojcc-e	22		22				
TU-23-33B	Ojcc-b	14		14		3	1	
TU-23-33B	Ojcc-o	2		2				
TU-23-34A	Mch	4		4	1			
TU-23-34A	Ojcc-e	6		6		2		
TU-23-34A	Ojcc-b	4		4		1		
TU-23-34B	Mbk	2		2				
TU-23-34B	Mch	6		6		1		
TU-23-34B	Ojcc-e	4		4		1		
TU-23-34B	Ojcc-o	1		1		1		
TU-23-35A	Mbk	3		3		3		
TU-23-35A	Mch	4		4				
TU-23-35A	Ojcc-e	9		9		1		
TU-23-35A	Ojcc-b	3		3			1	
TU-23-35B	Mch	2		2				
TU-23-35B	Ojcc-e	2		2				
TU-23-35B	Ojcc-o	1		1				
TU-23-36A	Ojcc-e	1		1				
TU-23-36B	Ojcc-e	1		1		1		
TU-23-36B	Ojcc-b	1		1				
TU-24-30A	Mbk	1		1				
TU-24-30A	Ojcc-e	2		2		2		
TU-24-30A	Ojcc-b	5		5			1	
TU-24-30B	Ojcc-e	5		5		3		
TU-24-30B	Ojcc-b	4		4				
TU-24-31A	Ojcc-e	7		7		1		
TU-24-31A	Ojcc-b	6		6				
TU-24-31B	Mbk	2		2		1		
TU-24-31B	Mch	3		3				
TU-24-31B	Ojcc-e	12		12		2		
TU-24-31B	Ojcc-b	9		9		2		
TU-24-31B	Ojcc-m	1		1				
TU-24-32A	Mbk	2		2		1		
TU-24-32A	Mch	1		1				
TU-24-32A	Ojcc-e	9		9				
TU-24-32A	Ojcc-b	3		3				
TU-24-32B	Mch	3		3				
TU-24-32B	Ojcc-e	10		10		2		
TU-24-32B	Ojcc-b	4		4	1			
TU-24-33A	Mbk	1		1				
TU-24-33A	Mch	2		2				
TU-24-33A	Ojcc-e	14		14		2		
TU-24-33A	Ojcc-b	8		8		1	2	
TU-24-33A	Ojcc-o	1		1				
TU-24-33B	Mch	2		2				
TU-24-33B	Ojcc-e	6		6		2		
TU-24-33B	Ojcc-b	9		9		1	1	
TU-24-33B	Ojcc-m	1		1				
TU-24-34A	Mbk	2		2		1		
TU-24-34A	Ojcc-e	14		14		3		
TU-24-34A	Ojcc-b	11		11				
TU-24-34B	Mbk	5		5		1		
TU-24-34B	Mch	5		5		1		
TU-24-34B	Ojcc-e	24		24		8		
TU-24-34B	Ojcc-b	10		10		1		

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-24-34B	Ojcc-o	1		1				
TU-24-35A	Mch	2		2		1		
TU-24-35A	Ojcc-e	16		16		5		
TU-24-35A	Ojcc-b	13		13		1	1	
TU-24-35A	Ojcc-m	3		3		1		
TU-24-35B	Mbk	1		1				
TU-24-35B	Mch	1		1				
TU-24-35B	Ojcc-e	2		2				
TU-24-36A	Ojcc-e	7		7		2		
TU-24-36A	Ojcc-b	2		2		1		
TU-24-36B	Mch	2		2		2		
TU-24-36B	Ojcc-e	2		2				
TU-24-37A	Ojcc-b	2		2		1		
TU-24-37B	Mch	2		2		1		
TU-24-37B	Ojcc-e	3		3		1		
TU-24-37B	Ojcc-b	1		1				
TU-24-38A	Ojcc-e	1		1				
TU-24-38A	Ojcc-b	1		1				
TU-24-38B	Ojcc-b	1		1				
TU-25-30	Mbk	12	2	10		2		08LP
TU-25-30	Mch	7		7				08LP
TU-25-30	Ojcc-m	14		14	1		1	08LP
TU-25-30	Ojcc-b	33		33				08LP
TU-25-30	Ojcc-e	68	3	65		9	2	08LP
TU-25-31	Mpk	1		1				08LP
TU-25-31	Mbk	30	8	22		1		08LP
TU-25-31	Mch	10		10		2		08LP
TU-25-31	Ojcc-e	187	2	185	4	28		08LP
TU-25-31	Ojcc-b	51	1	50	1	2	1	08LP
TU-25-31	Ojcc-m	24	1	23		1		08LP
TU-25-31	Ojcc-o	3		3				08LP
TU-25-32	Mbk	17	1	16		1		08LP
TU-25-32	Mch	14		14		5		08LP
TU-25-32	Ojcc-e	201		201	1	18		08LP
TU-25-32	Ojcc-b	27		27		2		08LP
TU-25-32	Ojcc-m	11	1	10	1	1		08LP
TU-25-32	Ojcc-o	1		1				08LP
TU-25-33	Mbk	6		6		1		09EP
TU-25-33	Mch	6		6				09EP
TU-25-33	Ojcc-e	96	2	94	1	9		09EP
TU-25-33	Ojcc-b	18		18				09EP
TU-25-33	Ojcc-m	13		13		1		09EP
TU-25-33	Ojcc-o	4		4				09EP
TU-25-34	Mbk	5		5		1		09EP
TU-25-34	Mch	2		2			1	09EP
TU-25-34	Ojcc-e	43		43		3		09EP
TU-25-34	Ojcc-b	12		12		1		09EP
TU-25-34	Ojcc-m	5		5		2		09EP
TU-25-34	Ojcc-o	3		3				09EP
TU-25-35A	Ojcc-e	7	1	6		2		09EP
TU-25-35A	Ojcc-b	1		1			1	09EP
TU-25-35A	Ojcc-m	2		2				09EP
TU-25-35B	Ojcc-e	8		8		1		09EP
TU-25-35B	Ojcc-m	3		3				09EP
TU-25-36A	Ojcc-e	3		3		1		09EP
TU-25-36A	Ojcc-b	1		1				09EP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-25-36B	Mbk	1		1				09EP
TU-25-36B	Ojcc-e	5		5				09EP
TU-25-37A	Mch	1		1			1	09EP
TU-25-37A	Ojcc-b	1		1				09EP
TU-25-37A	Ojcc-m	1		1				09EP
TU-25-37B	Ojcc-e	1		1		1		09EP
TU-25-38A	Ojcc-m	1		1				10PP
TU-25-38B	Mbk	1		1				10PP
TU-25-39	Mbk	1		1				10PP
TU-25-39	Ojcc-e	1		1				10PP
TU-25-39	Ojcc-b	1		1				10PP
TU-26-29B	Mbk	3		3				
TU-26-29B	Mch	3		3		2		
TU-26-29B	Ojcc-e	20		20	1	5		
TU-26-29B	Ojcc-b	13		13				
TU-26-29B	Ojcc-m	2		2				
TU-26-29B	Ojcc-c	1		1		1		
TU-26-30	Mbk	20		20		2		08LP
TU-26-30	Mch	30		30		5		08LP
TU-26-30	Ojcc-e	298	1	297	2	33	1	08LP
TU-26-30	Ojcc-b	177		177	1	9	1	08LP
TU-26-30	Ojcc-c	15		15		1		08LP
TU-26-30	Ojcc-m	11		11				08LP
TU-26-30	Ojcc-o	5	1	4				08LP
TU-26-30	Ojcc-q	2		2				08LP
TU-26-30	Mpk	1		1				08LP
TU-26-31	Mbk	12		12		2		08LP
TU-26-31	Mch	13		13		1		08LP
TU-26-31	Ojcc-e	178	1	177		18		08LP
TU-26-31	Ojcc-b	106		106	2			08LP
TU-26-31	Ojcc-c	5		5		1		08LP
TU-26-31	Ojcc-o	1		1				08LP
TU-26-31	Ojcc-m	5		5				08LP
TU-26-31	Ojcc-q	2		2				08LP
TU-26-32	Mbk	1		1				08LP
TU-26-32	Mch	5		5				08LP
TU-26-32	Ojcc-e	85		85		8	1	08LP
TU-26-32	Ojcc-b	17		17	1	2		08LP
TU-26-32	Ojcc-c	1		1		1		08LP
TU-26-32	Ojcc-o	1		1				08LP
TU-26-33A	Mbk	1		1				09EP
TU-26-33A	Mch	2		2				09EP
TU-26-33A	Ojcc-e	7		7		1		09EP
TU-26-33A	Ojcc-b	8		8				09EP
TU-26-33B	Mbk	2		2				09EP
TU-26-33B	Mch	1		1				09EP
TU-26-33B	Ojcc-e	17		17		3		09EP
TU-26-33B	Ojcc-b	7		7				09EP
TU-26-33B	Ojcc-q	1		1				09EP
TU-26-34A	Mch	2		2				09EP
TU-26-34A	Ojcc-e	11		11		2		09EP
TU-26-34A	Ojcc-b	3		3				09EP
TU-26-34A	Ojcc-m	1		1				09EP
TU-26-34B	Mch	1		1				09EP
TU-26-34B	Ojcc-e	9		9		1		09EP
TU-26-35A	Mbk	2		2				09EP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Alluvial	Indeterminate	Component
TU-26-35A	Mch	1		1				09EP
TU-26-35A	Ojcc-e	4		4		2		09EP
TU-26-35A	Ojcc-b	1		1				09EP
TU-26-35B	Ojcc-e	1		1		1		09EP
TU-27-30	Mbk	13		13		3		08LP
TU-27-30	Mch	33		33		1	2	08LP
TU-27-30	Ojcc-e	80	1	79		9		08LP
TU-27-30	Ojcc-b	32		32		3		08LP
TU-27-30	Ojcc-m	2		2				08LP
TU-27-30	Ojcc-o	1		1				08LP
TU-27-31	Mbk	15		15		6		08LP
TU-27-31	Mch	103	1	102		2		08LP
TU-27-31	Ojcc-e	239		239		31		08LP
TU-27-31	Ojcc-b	79		79	1	5	2	08LP
TU-27-31	Ojcc-m	3		3				08LP
TU-27-31	Ojcc-o	2		2				08LP
TU-27-32	Mbk	1		1				08LP
TU-27-32	Mch	17	3	14			1	08LP
TU-27-32	Ojcc-e	45		45		6		08LP
TU-27-32	Ojcc-b	24		24		3	1	08LP
TU-27-32	Ojcc-m	2		2				08LP
TU-27-32	Ojcc-o	1		1				08LP
TU-27-33A	Mbk	1		1			1	09EP
TU-27-33A	Mch	5		5				09EP
TU-27-33A	Ojcc-e	16		16		4		09EP
TU-27-33A	Ojcc-b	4		4		1		09EP
TU-27-33A	Ojcc-o	1		1			1	09EP
TU-27-33A	Ojcc-m	1		1	1			09EP
TU-27-33B	Mch	4		4		1		09EP
TU-27-33B	Ojcc-e	8		8		3		09EP
TU-27-33B	Ojcc-b	5		5				09EP
TU-27-34A	Mch	7	2	5		1		09EP
TU-27-34A	Ojcc-e	9		9		1	1	09EP
TU-27-34A	Ojcc-b	3		3				09EP
TU-27-34A	Ojcc-m	3		3				09EP
TU-27-34B	Mbk	1		1				09EP
TU-27-34B	Ojcc-e	7		7				09EP
TU-27-34B	Ojcc-b	4		4	1			09EP
TU-27-34B	Ojcc-m	2		2				09EP
TU-27-35A	Mch	1		1		1		09EP
TU-27-35A	Ojcc-e	2		2			1	09EP
TU-27-35A	Ojcc-b	2		2				09EP
TU-27-35B	Mbk	1		1				09EP
TU-27-35B	Mch	1		1				09EP
TU-27-35B	Ojcc-e	2		2		1		09EP
TU-28-30	Mbk	2		2				
TU-28-30	Ojcc-e	23		23		2		
TU-28-30	Ojcc-b	16		16		3	1	
TU-28-30	Ojcc-m	1		1				
TU-28-30	Ojcc-o	1		1				
TU-28-30	Ojcc-c	1		1				
TU-28-31	Mbk	7		7		1		
TU-28-31	Mch	6		6				
TU-28-31	Ojcc-e	73		73		4	1	
TU-28-31	Ojcc-b	44		44		8	1	
TU-28-31	Ojcc-m	5	1	4				

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-28-32	Mbk	4		4				
TU-28-32	Mch	4		4		1		
TU-28-32	Ojcc-e	24		24		2		
TU-28-32	Ojcc-b	17		17		1		
TU-28-32	Ojcc-m	3		3		1		
TU-28-33	Mbk	5		5				
TU-28-33	Mch	8		8		1		
TU-28-33	Ojcc-e	42		42		4		
TU-28-33	Ojcc-b	33		33		5	1	
TU-28-33	Ojcc-m	3		3				
TU-28-34A	Mch	3		3		1		
TU-28-34A	Ojcc-e	27		27		1		
TU-28-34A	Ojcc-b	17		17		1	1	
TU-28-34A	Ojcc-m	1		1				
TU-28-34A	Ojcc-o	1		1				
TU-28-34A	Ojcc-q	1		1		1		
TU-28-34B	Mbk	1		1				
TU-28-34B	Mch	5		5				
TU-28-34B	Ojcc-e	29		29		3	1	
TU-28-34B	Ojcc-b	10		10		1		
TU-28-34B	Ojcc-m	1		1				
TU-28-35A	Mbk	1		1				
TU-28-35A	Ojcc-e	12		12		3		
TU-28-35A	Ojcc-b	6		6				
TU-28-35B	Mbk	3	1	2				
TU-28-35B	Mch	1		1				
TU-28-35B	Ojcc-e	19		19	1	2		
TU-28-35B	Ojcc-b	2		2				
TU-28-35B	Ojcc-m	2		2				
TU-28-36	Mch	3		3				
TU-28-36	Ojcc-e	16		16		2		
TU-28-36	Ojcc-b	10		10		1		
TU-28-36	Ojcc-o	1		1				
TU-28-36A	Mbk	2		2				
TU-28-36A	Mch	1		1				
TU-28-36A	Ojcc-e	8		8		3		
TU-28-36A	Ojcc-b	1		1				
TU-28-36A	Ojcc-m	1		1		1		
TU-29-30	Ojcc-e	6		6				
TU-29-31	Mbk	1		1				
TU-29-31	Ojcc-e	6	1	5				
TU-29-31	Ojcc-b	4		4				
TU-29-32	Mbk	1		1		1		
TU-29-32	Mch	2		2				
TU-29-32	Ojcc-e	13		13				
TU-29-32	Ojcc-b	10		10	1	2		
TU-29-32	Ojcc-m	1		1				
TU-29-33	Mch	2		2		1		
TU-29-33	Ojcc-e	8		8				
TU-29-33	Ojcc-b	5		5		1		
TU-29-33	Ojcc-m	1		1				
TU-29-34	Mbk	1		1				
TU-29-34	Mch	2		2			1	
TU-29-34	Ojcc-e	23	1	22	1			
TU-29-34	Ojcc-b	10		10				
TU-29-34	Ojcc-m	2		2		1		

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-30-31B	Mpk	1		1				08LP
TU-30-31B	Mbk	4		4		1		08LP
TU-30-31B	Mch	1		1				08LP
TU-30-31B	Ojcc-e	26		26		1		08LP
TU-30-31B	Ojcc-b	18		18				08LP
TU-30-32A	Ojcc-e	2		2				08LP
TU-30-32A	Ojcc-q	1		1				08LP
TU-30-32B	Ojcc-e	1		1				08LP
TU-31-30	Mch	2		2		1		
TU-31-30	Ojcc-e	3		3				
TU-31-31	Mch	1		1				
TU-31-31	Ojcc-e	4		4		1		
TU-31-31	Ojcc-b	2		2				
TU-31-32	Mch	4		4				
TU-31-32	Ojcc-e	19		19	1	3		
TU-31-32	Ojcc-b	4		4			1	
TU-31-32	Ojcc-m	3		3				
TU-31-33	Mbk	1		1				
TU-31-33	Mch	4		4				
TU-31-33	Ojcc-e	16		16	1	6		
TU-31-33	Ojcc-b	6		6		1		
TU-31-33	Ojcc-m	3		3				
TU-32-30	Mbk	3		3				08LP
TU-32-30	Mch	10		10				08LP
TU-32-30	Ojcc-e	15	1	14		2		08LP
TU-32-30	Ojcc-b	6		6		2		08LP
TU-32-30	Ojcc-m	2		2				08LP
TU-32-30	Ojcc-o	1		1				08LP
TU-32-31	Mbk	2		2				08LP
TU-32-31	Mch	26		26		2	1	08LP
TU-32-31	Ojcc-e	48		48		2		08LP
TU-32-31	Ojcc-b	6		6				08LP
TU-32-31	Ojcc-o	2		2				08LP
TU-32-32	Mbk	5	1	4				08LP
TU-32-32	Mch	15		15				08LP
TU-32-32	Ojcc-e	30	1	29		4	1	08LP
TU-32-32	Ojcc-b	8		8		1	1	08LP
TU-32-32	Ojcc-m	2		2				08LP
TU-32-32	Ojcc-q	1		1		1		08LP
TU-33-31A	Mch	2		2				08LP
TU-33-31A	Ojcc-e	11		11		2		08LP
TU-33-31A	Ojcc-b	7		7				08LP
TU-33-31A	Ojcc-m	4		4				08LP
TU-33-31B	Mch	1		1				08LP
TU-33-31B	Ojcc-e	22		22		4		08LP
TU-33-31B	Ojcc-b	5		5				08LP
TU-33-31B	Ojcc-m	2		2				08LP
TU-33-32A	Ojcc-e	4		4				08LP
TU-33-32A	Ojcc-b	2	1	1		1		08LP
TU-33-32A	Ojcc-o	6		6				08LP
TU-33-32B	Ojcc-b	1		1				08LP
TU-34-31	Mbk	47		47		19		08LP
TU-34-31	Ojcc-e	71		71	6	4		08LP
TU-34-31	Ojcc-b	2		2				08LP
TU-34-32A	Ojcc-e	1		1			1	08LP
TU-35-31	Mbk	2	1	1				08LP

Debitage Attribute Data.

Provenience	Raw Material	Total	Heat Treated	Not Heat Treated	Cortex Type: Residual	Cortex Type: Alluvial	Cortex Type: Indeterminate	Component
TU-35-31	Mch	1		1		1		08LP
TU-35-31	Ojcc-e	11	3	8		1		08LP
TU-35-31	Ojcc-b	5		5				08LP
TU-35-31	Ojcc-m	3		3		2		08LP
TU-35-31	Ojcc-q	1		1				08LP
TU-35-32A	Mch	1		1	1			08LP
TU-35-32A	Ojcc-e	7		7		1		08LP
TU-35-32A	Ojcc-b	14		14		2		08LP
TU-35-32A	Ojcc-m	10		10				08LP
TU-35-32A	Ojcc-q	1		1				08LP
TU-35-32B	Mch	1		1				08LP
TU-35-32B	Ojcc-e	2		2		1		08LP
TU-37-31A	Mch	1		1				08LP
TU-37-31A	Ojcc-e	14	1	13		5		08LP
TU-37-31A	Ojcc-b	8		8		1		08LP
TU-37-31A	Ojcc-m	6		6		3		08LP
TU-37-31B	Ojcc-b	1		1				08LP
TU-37-31B	Ojcc-m	2		2				08LP
TU-37-32	Ojcc-b	3		3		3		08LP

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
A-BD/01	Scallorn	Mbk	Yes	X						01LW/M	01WM
A-BD/02	Scallorn	Mbk	Yes	X						01LW/M	01WM
A-BD/03	Secondary biface	Mbk	Yes	S							
A-BD/04	Secondary biface	Mbk	Yes	X							
A-BD/05	Side scraper	Pw-bk	No	S							
ASS-2.1-2.4/01	Secondary biface	Mbk	Yes	S							03MLA
ASS-2.1-2.4/02	Unspecified scraper	Mbk	No	S							03MLA
ASS-2.1-2.4/03	Side scraper	Mbk	Yes	R							03MLA
ASS-2.3-2.4/01	Williams	Mbk	Yes	R						03MLA	03MLA
ASS-2.3-2.4/02	Williams	Mbk	Yes	X						03MLA	03MLA
ASS-2.3-2.4/03	Secondary biface	Mbk	Yes	I							03MLA
ASS-2.3-2.4/04	Tertiary biface	Mbk	Yes	X							03MLA
ASS-2.3-2.4/05	Side scraper	Mbk	No	R							03MLA
ATS-1.2/01	PPK	Mbk	No	X							
ATS-1.2/02	Secondary biface	Mbk	Yes	X							04ELA
ATS-1.25/01	Smith	Ojcc-o	No	X						04ELA	04ELA
ATS-1.5-1.6/01	Primary biface	Mbk	No	R							04ELA
ATS-1.6-1.7/01	Utilized flake	Mbk	No	R							04ELA
ATS-1.6-1.7/02	Utilized flake	Mbk	Yes	X							04ELA
ATS-1.6-1.7/03	Secondary biface	Mbk	Yes	X							04ELA
B-BD/01	Tertiary biface	Ojcc-m	No	X			0.86	H	M		
B-BD/02	Graham Cave	Ojcc-e	No	X		2.71	0.86	U	D	06LEA	06LEA
B-BD/03	Secondary biface	Mbk	No	X							
BT-1/01	Castorville	Mbk	Yes	X					M	03LLA	03LLA
BT-1/02	Secondary biface	Ojcc-q	No	X					T		
BT-1/03	Tertiary biface	Mbk	Yes	X					T		
BT-2/01	Graham Cave	Ex	No	X		2.81	0.80	U	T	07EEA	07EEA
BT-2/02	Secondary biface	Mch	No	X				F	T		
BT-2/03	Secondary biface	Mbk	Yes	X				E	M		
BT-2/04	Secondary biface	Mch	No	X				F	D		
BT-2/05	Secondary biface	Mch	No	X				F	T		
BT-2/06	Secondary biface	Mbk	Yes	X				F	T		
BTS-0.1-.75/01	Little Sac	Ojcc-e	Yes	X						021W	021W
BTS-0.1-1.2/01	Secondary biface	Mbk	Yes	R							04ELA
BTS-1.1-1.4/01	Adze	Ojcc-b	No	I							04ELA
BTS-1.3-1.5/01	Utilized flake	Mbk	No	R							05MA
BTS-1.3-1.8/01	Secondary biface	Ojcc-m	No	X							05MA
BTS-1.3-1.8/02	Primary biface	Mbk	No	R							05MA
BTS-1.3-1.8/03	Utilized flake	Mbk	No	X							05MA
BTS-1.8-2.0/01	Primary biface	Mbk	No	S							06LEA
BTS-22/01	Graham Cave	Mbk	No	X	5.89	2.63	0.79		C	06LEA	06LEA
BTS-24/01	Secondary biface	Mbk	No	X	13.08	3.63	0.86		C		07EEA

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
BTS-25-29/01	Secondary biface	Mbk	No	X			1.35	F	T		07EEA
C-0.2-0.3M/01	Smith	Mbk	Yes	X						04ELA	04ELA
C-BD/01	Utilized flake	Mbk	No	X							
CB/01	Secondary biface	Ojcc-m	No	X		4.06	1.02	H	M		
CB/02	Hidden Valley	Ojcc-b	Yes	X		2.89	0.89	U	T	06LEA	06LEA
CB/03	Dalton	Ojcc-e	No	S		2.68	0.56	U	T	08LP	08LP
CB/04	Secondary biface	Ojcc-b	No	X		5.79	0.79	F	T		
CB/05	Dalton	Ojcc-o	No	X		2.89	0.53	U	T	08LP	08LP
CB/06	Dalton	Mbk	No	X		2.30	0.71	U	B.	08LP	08LP
CB/07	Core	Ojcc-e	No	S							
CB/08	Adze	Mbk	Yes	X					C		
CTS-1.5-2.5/01	Secondary biface	Mbk	No	X		4.26	1.52	U	T		06LEA
CTS-1.5-2.5/02	Drill	Ojcc-m	No	I					T		06LEA
CTS-2.6-2.9/01	Primary biface	Ojcc-b	No	X		5.50	1.63	F	T		07EEA
D-BD/01	Primary biface	Mch	No	X		7.25	2.11	F	T		
D-BD/02	Secondary biface	Mbk	No	X		3.68	1.50	F	T		
D-BD/03	Secondary biface	Mbk	No	S			0.91	F	M		
D-BD/04	Secondary biface	Ojcc-b	No	X			1.39	F	D		
D-BD/05	Secondary biface	Ojcc-b	No	X		4.68	1.02	F	D		
D-BD/06	Secondary biface	Ojcc-e	No	S			0.77	F	T		
ER-S/01	Tertiary biface	Mbk	Yes	X				U	M		
ER-S/02	Tertiary biface	Ojcc-m	Yes	X				U	M		
ER-S/03	Secondary biface	Ojcc-b	No	X			0.90	F	T		
ER-S/04	Secondary biface	Ojcc-e	No	X		5.06	1.00	F	M		08LP
ER-S/05	Secondary biface	Ojcc-e	No	X		3.33	0.74	F	T		08LP
ER-S/06	Secondary biface	Ojcc-e	No	X				E	M		08LP
ER-S/07	Secondary biface	Ojcc-e	No	X			0.85	K	M		08LP
ER-S/08	Secondary biface	Ojcc-e	No	X			1.21	F	SO		08LP
ER-S/09	Secondary biface	Ojcc-b	No	X				F	M		08LP
ER-S/10	Secondary biface	Ojcc-e	No	R		4.91	1.52	F	D		08LP
ER-S/11	Primary biface	Ojcc-e	No	R	9.95	5.69	2.17		C		08LP
ER-S/12	Dalton adze	Mch	No	X	6.91	3.46	1.30		C	08LP	08LP
ER-S/13	End scraper	Mpk	No	R					C		08LP
ER-S/14	End scraper	Mrs-l	No	X					C		08LP
ER-S/15	End scraper	Ojcc-e	No	S				U	D		08LP
ER-S/16	Utilized flake	Mbk	No	S					C		
ER-S/17	Utilized flake	Mrs-m	No	X					C		
ER-S/21	End scraper	Mrs-m	No	X					C		
F-15/01	Utilized flake	Ojcc-e	No	X					C		01WM
F-17/01	Pol-Other	Mbk	No	X					C		04ELA
F-26/01	Primary biface	Mch	No	X		6.10	2.73	F	T		08LP
F-26/02	Pol-Adze	Ojcc-e	No	X					C		08LP

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
F-28/01	Secondary biface	Mbk	No	S				E	M		08LP
F-28/02	Secondary biface	Ojcc-b	No	X			1.29	F	D		08LP
F-28/03	Secondary biface	Ojcc-b	No	X			0.80	F	D		08LP
F-28/04	Secondary biface	Ojcc-b	No	X			1.43	F	M		08LP
F-28/05	Secondary biface	Ojcc-b	No	X				E	H		08LP
F-28/06	Side scraper	Ojcc-b	No	R					C		08LP
F-28/07	Utilized flake	Ojcc-b	No	R					T		08LP
F-28/08	Secondary biface	Ojcc-e	No	X		4.48	1.44	F	T		08LP
F-28/09	Pol-Other	Ojcc-e	No	X					C		08LP
F-28/10	Utilized flake	Ojcc-e	No	X					C		08LP
F-28/11	End scraper	Ojcc-e	No	S					C		08LP
F-28/12	Primary biface	Ojcc-e	No	X				E	M		08LP
F-28/13	Primary biface	Ojcc-e	No	S			3.71	F	L		08LP
F-28/14	Secondary biface	Ojcc-e	No	X		5.58	1.05	F	T		08LP
F-28/15	Primary biface	Ojcc-e	No	S			1.92	F	D		08LP
F-28/16	Pol-Other	Ojcc-e	No	X					C		08LP
F-28/17	Pol-Other	Ojcc-e	No	X					C		08LP
F-28/18	Pol-Other	Ojcc-e	No	X					C		08LP
F-28/19	San Patrice	Ojcc-o	No	X	3.63	2.70	0.51		C	08LP	08LP
F-29/01	Side scraper	Ojcc-e	No	R					C		08LP
F-29/02	Pol-Adze	Ojcc-e	No	X					C		08LP
F-36/01A	Secondary biface	Ojcc-e	No	S	9.44	5.66	1.50	F	T		08LP
F-36/01B	Secondary biface	Ojcc-e	No	S					C		08LP
F-36/02	Secondary biface	Ojcc-e	No	R		3.85	0.65	F	T		08LP
F-38/01	Tertiary biface	Ojcc-e	No	X				E	M		08LP
F-41/01	Primary biface	Ojcc-e	No	S	10.75	10.24	4.92		C		08LP
F-42/01	Secondary biface	Ojcc-e	No	X				E	L		08LP
F-45/01	Secondary biface	Ojcc-e	No	X		5.47	0.98	F	T		08LP
G-S/01	Cache River	Ojcc-m	No	X	4.99	2.12	0.60		C	07EEA	07EEA
G-S/02	Williams	Mbk	Yes	X					C	03MLA	03MLA
G-S/03	Scallorn	Mbk	Yes	X					D	01LW/M	01WM
G-S/04	End scraper	Ojcc-o	No	X					C		
G-S/05	End scraper	Ex	No	X					C		
GB/01	Hidden Valley	Ojcc-e	Yes	X		3.01	0.81	U	T	06LEA	06LEA
GB/02	Afton	Mbk	Yes	X				U	T	03LLA	03LLA
GB/03	Standlee	Ojcc-b	No	X				U	T	021W	021W
GB/04	Searcy	Mbk	Yes	X	6.19	2.31	0.86		C	06LEA	06LEA
GB/05	Drill	Mrs-l	No	S					C		
GB/06	St. Charles-like	Ojcc-o	No	X					C	07EEA	07EEA
LR-S/01	Smith	Ojcc-m	No	X						04ELA	04ELA
LR-S/02	Table Rock	Mbk	No	S						04ELA	04ELA
LR-S/03	Unidentifiable Woodland ppk	Mbk	Yes	X						021W	021W

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
LR-S/04	Scallorn	Mbk	Yes	X						01LW/M	01WM
LR-S/05	Scallorn	Mch	Yes	X						01LW/M	01WM
LR-S/06	Unidentifiable arrow point	Mbk	No	X						01LW/M	01WM
LR-S/07	Unidentifiable ppk	Mbk	Yes	X						10IN	
LR-S/08	Unidentifiable Woodland ppk	Mbk	Yes	S						021W	021W
LR-S/09	Etley	Mbk	No	X						04ELA	04ELA
LR-S/10	Secondary biface	Mbk	Yes	X							
LR-S/11	Scallorn	Ojcc-e	No	S						01LW/M	01WM
MR-S/01	Graham Cave	Mbk	No	X			0.84			06LEA	
MR-S/02	Castorville	Mbk	Yes	X						03LLA	03LLA
MR-S/03	Kings	Mch	Yes	X						021W	021W
MR-S/04	Tertiary biface	Mbk	No	X							
PCB/21	Rice Lobed	Ojcc-q	No	X						06LEA	
PCB/22	Jakie	Ojcc-o	No	X						06LEA	
PCB/23	Searcy	Mbk	Yes	X						06LEA	
PCB/24	Kings	Mbk	Yes	X						021W	
PCB/25	Kings	Mbk	Yes	X						021W	
PCB/26	Kings	Mch	Yes	X						021W	
PCCC/29	Packard	Ojcc-b	No	X						07EEA	
PCCC/30	Packard	Mbk	No	X						07EEA	
PCL/16	Gainey	Mrs-l	No	X						09EP	
PCL/17	Eastern Folsom/Sedgwick	Ojcc-e	Yes	X						09EP	
PCL/18	Dalton	Mrs-l	No	X						08LP	
PCL/27	Packard	Mbk	No	X						07EEA	
PCM/01	Cache River	Mbk	No	X						07EEA	
PCM/02	Graham Cave	Mbk	No	X						06LEA	
PCM/03	Dalton adze	Ojcc-e	No	X						08LP	
PCM/04	Afton	Mbk	Yes	X						03LLA	
PCM/31	Packard	Ojcc-e	No	X						07EEA	
PCM/32	Searcy	Ojcc-o	No	X						06LEA	
PCM/33	Smith	Ojcq	No	X						04ELA	
PCTC/19	Clovis/Gainey	Mbk	Yes	X						09EP	
PCTC/20	Dalton	Mbk	No	X						08LP	
PCTC/28	Packard	Ojcc-m	Yes	X						07EEA	
PPK-1	Scallorn	Mbk	Yes	X						01LW/M	01WM
PPK-10	Smith	Mrs-l	No	X						04ELA	04ELA
PPK-11	Smith	Mbk	No	X						04ELA	04ELA
PPK-12	Afton	Mbk	Yes	X						03LLA	03LLA
PPK-13	Smith	Ojcc-e	No	S						04ELA	04ELA
PPK-14	Kings	Mbk	Yes	X						021W	021W
PPK-15	Smith	Ojcc-b	No	X						04ELA	04ELA
PPK-16	Smith	Mbk	No	X						04ELA	04ELA

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
PPK-17	Kings	Mbk	Yes	X						021W	021W
PPK-18	Kings	Mbk	Yes	X						021W	021W
PPK-19	Marcos	Mbk	Yes	S						021W	021W
PPK-2	Afton	Mbk	Yes	X						03LLA	03LLA
PPK-20	Kings	Mbk	Yes	S						021W	021W
PPK-21	Scallorn	Mbk	Yes	X						01LW/M	01WM
PPK-22	Kings	Mbk	Yes	X						021W	021W
PPK-23	Kings	Mch	Yes	X						021W	021W
PPK-24	Smith	Mbk	Yes	X						04ELA	04ELA
PPK-25	Kings	Mbk	Yes	X						021W	021W
PPK-26	Smith	Mbk	No	X						04ELA	04ELA
PPK-27	Etley	Ojcc-o	No	X						04ELA	04ELA
PPK-28	Lander	Mbk	Yes	X						021W	021W
PPK-29	Kings	Ojcc-b	Yes	X						021W	021W
PPK-3	Etley	Mbk	No	X						04ELA	04ELA
PPK-30	Etley	Mbk	No	X						04ELA	04ELA
PPK-32	Castorville	Mbk	Yes	X						03LLA	03LLA
PPK-36	Smith	Ojcc-o	No	X						04ELA	04ELA
PPK-37	Kings	Ojcc-b	Yes	X						04ELA	04ELA
PPK-4	Waubesa	Pfb	No	X						021W	021W
PPK-48	Smith	Ojcc-b	No	X						021W	021W
PPK-5	Kings	Mbk	Yes	X						04ELA	04ELA
PPK-6	Cupp	Mbk	No	X						021W	021W
PPK-7	Kings	Mbk	Yes	X						01LW/M	01WM
PPK-8	Drill	Mbk	Yes	X						021W	021W
PPK-9	Madison	Mbk	No	X						00M	01WM
SS-MR/01	Smith	Mbk	No	X					T	04ELA	04ELA
SS-MR/02	Axe	Mch	No	X					C		
SS-MR/03	Hammerstone	Mbk	No	S					C		
SSB-G/01	Smith	Ojcc-b	No	X					T	04ELA	04ELA
SSB-G/02	Smith	Mbk	No	X					T	04ELA	04ELA
SSB-G/03	Kings	Mbk	Yes	X					D	021W	021W
SSB-G/04	Kings	Mbk	Yes	X					C	021W	021W
SSB-G/05	Kings	Mch	Yes	X					M	021W	021W
SSB-G/06	Reeds	Mbk	Yes	X					C	01LW/M	01WM
SSB-G/07	Unidentifiable arrow point	Ojcc-o	Yes	X					D	01LW/M	01WM
SSB-G/08	Scallorn	Ojcc-e	No	X					T	01LW/M	01WM
SSB-NE/01	Lander	Ojcc-o	No	X					T	021W	021W
SSB-NE/02	Drill	Ojcc-o	No	X					U		
SSB-NW/01	Little Sac	Mbk	Yes	X					T	021W	021W
SSB-NW/02	Scallorn	Mbk	Yes	X					T	01LW/M	01WM
SSB-SE/01	Gary	Ojcc-m	No	X					T	021W	021W

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
SSB-SE/02	Scallorn	Ojcc-e	No	X					T	01LW/M	01WM
SSB-SE/03	Scallorn	Mbk	Yes	X					T	01LW/M	01WM
TU-02-13/01	Etley	Mbk	No	X	9.51	3.38	1.17	U	T	04ELA	04ELA
TU-04-26/01	Primary biface	Ojcc-b	No	X				E	F		07EEA
TU-04-28/01	Secondary biface	Mch	Yes	X				F	SO		07EEA
TU-04-29/01	Primary biface	Ojcc-q	No	R				F	IF		
TU-04-29/02	Secondary biface	Ojcc-b	No	S			1.31	F	D		
TU-04-30/05	Primary biface	Ojcc-b	No	S	12.10	9.41	4.89		C		08LP
TU-04-30/06	Secondary biface	Ojcc-b	No	X			1.59	F	M		08LP
TU-04-30/07	Utilized flake	Ojcc-b	No	R					C		08LP
TU-04-31/03	Side scraper	Ojcc-b	No	X					T		08LP
TU-04-31/04	Utilized flake	Ojcc-e	No	X					C		08LP
TU-04-31/05	Utilized flake	Ojcc-e	No	X					C		08LP
TU-04-31/05	Utilized flake	Ojcc-e	No	X					C		08LP
TU-04-31/06	Utilized flake	Ojcc-b	No	X					C		08LP
TU-04-32/01	Secondary biface	Mbk	Yes	X			1.30	F	L		08LP
TU-04-SW-29/03	End scraper	Ojcc-e	No	X					M		
TU-04-SW-30/01	Secondary biface	Ojcc-m	No	S					C		08LP
TU-04-SW-30/02	Primary biface	Ojcc-q	No	R		5.12	1.89	F	IF		08LP
TU-04-SW-30/03	Graver	Ojcc-e	No	X					C		08LP
TU-04-SW-30/04	Utilized flake	Ojcc-e	No	S					C		08LP
TU-04-SW-31/01	Utilized flake	Mch	No	S					C		08LP
TU-04-SW-31/02	Utilized flake	Ojcc-e	No	X					C		08LP
TU-05-24/01	Primary biface	Mbk	Yes	R	9.27	5.97	2.58		C		04ELA
TU-05-24/02	Utilized flake	Mbk	No	X					C		03MLA
TU-05-24/03	Utilized flake	Mbk	No	X					T		03MLA
TU-05-NE-26/01	Williams	Mbk	Yes	X	4.58	3.55	0.99		C	03MLA	03MLA
TU-05-SW-24/04	Utilized flake	Mbk	No	R					C		03MLA
TU-05-SW-25/01	Primary biface	Mbk	Yes	R				F	T		03MLA
TU-08-28/01	Utilized flake	Ojcc-b	Yes	X					M		07EEA
TU-08-29/01	Utilized flake	Mch	No	S					C		
TU-08-29/02	End scraper	Ojcc-e	No	S					C		
TU-08-30/02	Secondary biface	Ojcc-e	No	S	7.64	4.49	1.34		C		08LP
TU-08-31/02	Primary biface	Ojcc-e	No	S	13.68	8.58	3.44	F	T		08LP
TU-08-31/03	Utilized flake	Ojcc-e	No	S					C		08LP
TU-08-SW-30/01	Secondary biface	Ojcc-e	No	S	7.17	4.09	1.00		C		08LP
TU-08-SW-31/01	Secondary biface	Mch	No	X				E	A		08LP
TU-09-24/01	Williams	Mbk	Yes	S					D	03MLA	03MLA
TU-09-24/02	Secondary biface	Mbk	Yes	R		5.33	1.32	F	D		03MLA
TU-09-25/01	Williams	Mbk	Yes	X	5.28	4.33	0.88		C	03MLA	03MLA
TU-11-26/01	Tertiary biface	Ojcc-e	No	S		2.79	0.78	U	T		07EEA
TU-11-29/01	Secondary biface	Ojcc-e	No	X		4.43	1.03	F	D		

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
TU-12-29/01	Secondary biface	Ojcc-b	No	X				E	M		
TU-12-30/01	Secondary biface	Ojcc-b	No	X				F	L		08LP
TU-12-30/02	Secondary biface	Ojcc-b	No	X				E	O		08LP
TU-12-30/03	Secondary biface	Ojcc-b	No	X				E	L		08LP
TU-12-30/04	Utilized flake	Ojcc-o	No	X					C		08LP
TU-12-30/05	Utilized flake	Ojcc-e	No	R					C		08LP
TU-12-31/01	Primary biface	Mbk	No	S	7.12	4.50	1.83		C		08LP
TU-12-31/02	Primary biface	Ojcc-e	No	S			2.40	F	M		08LP
TU-12-31/03	Secondary biface	Ojcc-c	No	S		4.35	1.25	F	T		08LP
TU-13-30/01	Primary biface	Ojcc-e	No	S	8.22	5.89	3.26		C		08LP
TU-13-30/02	Secondary biface	Ojcc-e	No	S		5.29	1.30	F	M		08LP
TU-13-30/03	Secondary biface	Ojcc-e	No	X		6.12	0.73	F	D		08LP
TU-13-30/04	Secondary biface	Ojcc-o	No	X		3.89	0.91	F	D		08LP
TU-13-31/01	Primary biface	Ojcc-e	No	S				F	T		08LP
TU-13-31/02	Utilized flake	Mp-r	No	X					D		08LP
TU-14-31/01	Tertiary biface	Ojcc-e	No	X			0.49	K	M		08LP
TU-15-30/01	Unspecified scraper	Ojcc-e	No	S					T		08LP
TU-15-30/02	Primary biface	Ojcc-b	No	S	10.07	8.63	2.88		C		08LP
TU-15-30/03	Primary biface	Ojcc-e	No	S	7.30	4.82	2.43		C		08LP
TU-15-30/04	Secondary biface	Ojcc-e	No	X	6.16	4.43	1.11		C		08LP
TU-15-30/05	Secondary biface	Mbk	No	X				E	L		08LP
TU-15-30/06	Utilized flake	Mbk	No	S					C		08LP
TU-15-31/01	End scraper	Mrs-m	No	X					C		08LP
TU-16-30/01	Utilized flake	Mbk	No	X					C		08LP
TU-17-29/01	Primary biface	Ojcc-e	No	S				F	D		
TU-17-29/02	Utilized flake	Mch	No	S					C		
TU-17-30/01	Secondary biface	Ojcc-q	No	X		3.58	1.08	F	T		08LP
TU-17-30/02	San Patrice	Ojcc-b	No	X		1.94	0.38	U	I	08LP	08LP
TU-17-31/01	End scraper	Ojcc-e	No	X					T		08LP
TU-17-31/02	Secondary biface	Ojcc-e	No	X			1.16	F	D		08LP
TU-17-31/03	Utilized flake	Mp-r	No	R					T		08LP
TU-18-30/01	Primary biface	Ojcc-b	No	S			4.00	F	D		08LP
TU-18-30/02	Primary biface	Ojcc-b	No	X	5.69	4.00	1.74		C		08LP
TU-18-30/03	Secondary biface	Mch	No	X		8.15	1.03	F	T		08LP
TU-18-30/04	Secondary biface	Mbk	No	X		5.85	1.32	F	T		08LP
TU-18-30/05	Utilized flake	Ojcc-b	No	X					C		08LP
TU-18-30/06	End scraper	Ojcc-e	No	S					C		08LP
TU-18-30/07	San Patrice	Ojcc-e	No	X	3.68	2.30	0.50		C	08LP	08LP
TU-19-31/01	End scraper	Mbk	No	X					C		08LP
TU-20-30/01	Primary biface	Ojcc-b	No	S			2.85	F	M		08LP
TU-21-29/01	Secondary biface	Ojcc-b	No	X			1.05	F	M		
TU-21-30/02	Secondary biface	Ojcc-e	No	X		4.41	1.07	F	T		08LP

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period	Component
TU-21-30/03	Secondary biface	Ojcc-b	No	X				E	L		08LP
TU-21-30/04	Primary biface	Ojcc-q	No	I	5.46	5.06	2.83		C		08LP
TU-21-30/05	Primary biface	Ojcc-b	No	S		6.40	2.25	F	SO		08LP
TU-21-30/06	Secondary biface	Ojcc-b	No	X				E	L		08LP
TU-21-31/01A	Secondary biface	Mbk	No	S	9.66	2.97	0.80	F	M		08LP
TU-21-31/02	Secondary biface	Ojcc-e	No	X				E	M		08LP
TU-21-31/03A	Primary biface	Ojcc-b	No	S	11.20	8.92	4.93	F	T		08LP
TU-21-31/04	Primary biface	Ojcc-e	No	S		4.53	2.98	F	T		08LP
TU-21-31/05	End scraper	Ojcc-b	No	X					T		08LP
TU-21-31/06	Utilized flake	Mch	No	X					L		08LP
TU-21-31/07	Pol-Adze	Ojcc-b	No	S							08LP
TU-22-31/02	Secondary biface	Ojcc-b	No	X		4.60	0.86	F	T		08LP
TU-22-31/03	Primary biface	Mch	No	R		6.45	2.34	F	T		08LP
TU-22-31/04	Side scraper	Mch	No	S					C		08LP
TU-22-31/05	Utilized flake	Mch	No	X					C		08LP
TU-22-32/01	Tertiary biface	Ojcc-b	No	X			0.55	E	M		08LP
TU-22-32/02	Secondary biface	Ojcc-e	No	X				E	L		08LP
TU-22-32/03	Secondary biface	Ojcc-e	No	X				E	M		08LP
TU-22-32/04	Secondary biface	Mch	No	X				E	M		08LP
TU-22-32/05	Primary biface	Ojcc-b	No	X	6.05	4.06	2.31		C		08LP
TU-22-32/06	End scraper	Ojcc-e	No	S					C		08LP
TU-22-35B/01	Secondary biface	Ojcc-e	No	X			0.89	F	T		09EMP
TU-23-30/01	End scraper	Ojcc-e	No	X					C		
TU-23-32A/01	Secondary biface	Mbk	No	S				F	SO		
TU-23-33A/01	Wilson	Ex	No	X	5.38	2.47	0.78		C	08LP	08LP
TU-24-35A/01	Utilized flake	Ojcc-e	No	X					C		
TU-24-36B/01	End scraper	Mrs-m	No	R					C		
TU-25-30/01	Secondary biface	Ojcc-b	No	X				E	M		08LP
TU-25-30/02	Utilized flake	Ojcc-b	No	X					C		08LP
TU-25-31/01	Tertiary biface	Mbk	No	X			0.66	U	T		08LP
TU-25-31/02	Primary biface	Ojcc-e	No	S	9.68	7.16	2.67		C		08LP
TU-25-31/03	End scraper	Ojcc-b	No	R					C		08LP
TU-25-31/04	Unspecified scraper	Ojcc-e	No	X					M		08LP
TU-25-31/05	Unspecified scraper	Mch	No	X					C		08LP
TU-25-31/06	Utilized flake	Ojcc-e	No	X					C		08LP
TU-25-31/07	Pol-Other	Ojcc-e	No	S					C		08LP
TU-25-32/01	Secondary biface	Ojcc-e	No	S		5.42	1.29	F	T		08LP
TU-25-32/02	Pol-Other	Ojcc-e	No	X					C		08LP
TU-25-33/01	Pol-Other	Mbk	No	S					C		09EMP
TU-25-34/01A	Gainey	Mbk	No	X		2.98	0.64	U	T	09EP	09EMP
TU-25-34/01B	Gainey	Mbk	No	X				H	T	09EP	09EMP
TU-25-34/02	Clovis/Gainey	Mbk	No	X			0.68	E	M	09EP	09EMP

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period Component
TU-25-34/03	Utilized flake	Mbk	No	X					C	09EMP
TU-25-34/04	Utilized flake	Ojcc-e	Yes	X					D	09EMP
TU-25-34/05	Utilized flake	Ojcc-e	No	X					D	09EMP
TU-25-34/06	Utilized flake	Ojcc-m	No	S					D	09EMP
TU-25-34/07	End scraper	Ojcc-m	No	S					M	09EMP
TU-25-35B/01	Utilized flake	Ojcc-e	No	S					C	09EMP
TU-25-36A/01	Utilized flake	Ojcc-e	Yes	X					T	09EMP
TU-26-29/01	Secondary biface	Ojcc-b	No	X				E	SO	
TU-26-30/01	Drill	Ojcc-b	No	S		3.91	0.78	U	D	08LP
TU-26-30/02A	Secondary biface	Ojcc-e	No	S	6.99	3.26	1.06	F	T	08LP
TU-26-30/03A	Secondary biface	Ojcc-b	No	X	6.81	4.87	1.88	F	EO	08LP
TU-26-30/04	Primary biface	Ojcc-b	No	R			2.15	F	I	08LP
TU-26-30/05	Primary biface	Ojcc-b	No	R				F	SO	08LP
TU-26-30/06	Secondary biface	Ojcc-e	No	X				E	L	08LP
TU-26-30/07	Utilized flake	Ojcc-e	No	X					C	08LP
TU-26-30/08	Utilized flake	Ojcc-o	No	I					C	08LP
TU-26-31/01	Tertiary biface	Mbk	No	X		3.15	0.72	F	M	08LP
TU-26-31/02	Secondary biface	Ojcc-e	No	X				E	M	08LP
TU-27-30/01A	Secondary biface	Ojcc-m	No	S		3.88	0.98	H	M	08LP
TU-27-30/02	Side scraper	Ojcc-b	No	S					M	08LP
TU-27-30/03	Graver	Ojcc-e	No	X					C	08LP
TU-27-30/04	Utilized flake	Ojcc-b	No	X					C	08LP
TU-27-30/05	Utilized flake	Ojcc-e	No	X					L	08LP
TU-27-31/02	Secondary biface	Ojcc-m	No	X		3.72	0.63	F	D	08LP
TU-27-31/03A	Secondary biface	Ojcc-o	No	X			0.68	H	M	08LP
TU-27-31/04	Primary biface	Ojcc-b	No	R		5.39		F	SO	08LP
TU-27-31/05	Primary biface	Ojcc-b	No	S			4.06	F	IF	08LP
TU-27-31/06	Secondary biface	Ojcc-e	No	X				F	SO	08LP
TU-27-31/07	Secondary biface	Ojcc-b	No	X				F	M	08LP
TU-27-31/08	Utilized flake	Mch	No	S					C	08LP
TU-27-31/09	Utilized flake	Ojcc-b	No	S					C	08LP
TU-27-31/10	Pol-Adze	Ojcc-e	No	X					T	08LP
TU-27-31/11	Pol-Adze	Ojcc-b	No	X					C	08LP
TU-27-32/01	Utilized flake	Pw-bk	No	X					L	08LP
TU-27-33B/01	Graver	Ojcc-e	No	X					C	09EMP
TU-27-34A/01	Secondary biface	Ojcc-b	No	X			0.94	F	M	09EMP
TU-28-31/01	End scraper	Ex	No	R					C	
TU-28-32/01	Secondary biface	Ojcc-e	No	X			0.99	F	D	
TU-28-32/02	Utilized flake	Ojcc-b	No	X					C	
TU-28-32/03	Utilized flake	Mbk	No	S					C	
TU-28-33/01	Primary biface	Ojcc-m	No	S			4.46	F	M	
TU-28-34A/01	Secondary biface	Ojcc-m	No	X				E	M	

Chipped-Stone Tool Data.

Tool	Type	Raw Material	Heat Treated	Cortex Type	Length (cm)	Width (cm)	Thickness (cm)	Fragment Type	Break Type	Type Period Component
TU-28-35B/01	Utilized flake	Ojcc-b	No	R					C	
TU-30-31B/01	Secondary biface	Ojcc-e	No	X			0.78	F	D	08LP
TU-31-31/01	End scraper	Ojcc-b	No	X					C	
TU-31-32/01	Utilized flake	Ojcc-e	No	X					C	
TU-32-31/01	Utilized flake	Mch	No	X					C	08LP
TU-33-32/01	Secondary biface	Ojcc-e	No	X		4.49	0.90	F	T	08LP
TU-35-31/01	Primary biface	Mbk	No	S	8.29	4.34	2.06		C	08LP
TU-35-32/01	Secondary biface	Pdw	No	X		3.10	0.78	F	T	08LP
TU-35-33/01	Utilized flake	Ojcc-o	No	S					C	
TU-37-31/01	Primary biface	Ojcc-e	No	S	5.81	5.79	2.16		C	08LP

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